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OLEOCHEMICAL AND SURFACTANTS
US/INS/90/010

INDONESIA

Final report

PART I

Prepared for the Government of the Republic of Indonesia
by the United Nations Industrial Development Organization

by

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PARTS II and III presented as separate documents

ABBREVIATIONS LIST

Economic terms:

GDP	- Gross Domestic Product
MVA	- Manufacturing Value Added
PDA	- Production/Distribution Area (technological network of processing installations)
FCI	- Fixed Investment Cost
GPV	- Gross Production Value

Natural oils:

CPO	- Palm oil
PKO	- Palm kernel oil
CNO	- Coconut oil

Statistical chapters:

SITC	- Statistical International Trade Code
311	- food production
321	- textiles
341	- paper and paper products
351	- industrial chemicals
352	- other chemical products
353	- petroleum refineries
354	- miscellaneous petroleum and coal products
355	- rubber products
356	- plastic products
382	- non-electrical machinery
384	- transport equipment

Strategies:

Trade strategies

EO	- Export oriented
EI	- Export balancing imports
IO	- Import Oriented

Investment financing strategies:

SF	- Self-financing
FCF	- Foreign Credits
FJV	- Foreign Joint-Ventures

Structural patterns

FS	- full structure in a given branch
LS	- limited structure in a given branch
NS	- out of structure investments

Selected surfactants:

LABS	- linear alkylbenzene sodium sulfate
FAE	- fatty alcohols etoxylate
SLS	- sodium fatty alcohol sulfate
SLES	- sodium fatty alcohol etoxylate sulfate
NPES	- sodium nonylphenoletoksylate sulfate
TEA	- trietanolamine

EXECUTIVE SUMMARY

Indonesia is one of the South-East Asian countries becoming a candidate to the group of NICs (Newly Industrialized Countries). The country fulfils all necessary conditions for industrial development and may be characterized by:

- large scale local market allowing for establishment of economic size installations;
- abundance of hydrocarbon resources;
- abundance of natural resources of agricultural origin;
- stable and advantageous economic system attracting foreign investments;
- satisfactory infrastructure and especially well established banking system.

However, this "embarrass de richesse" poses high responsibility on shoulders of decision makers. The options for development are not obvious, and selection of investment projects priorities requires numerous studies and neutral assessment. On the one hand it could be advantageous to follow the established way of development of the petrochemical industry and add more value to the hydrocarbon resources. However, on the other hand agriculture employs over 50% of the population and introduction of agro-products processing industrial structure may have positive impact on the increase of farmers income as well as on the industrialization process. The selection of the most advantageous option is also important from the point of view of international competition.

The export promotion strategy initiated in 1983 may bring positive results in the long term only when commodities will be produced accordingly to the modern technology and competitive in terms of used raw material and manpower costs.

One obvious candidate for project selection priority exercise is the branch of surfactants and detergents. All the natural raw materials exist in Indonesia and could be processed to high value added products for local consumption and export. Development of the Development of the petrochemical industry in Indonesia gives also opportunity that applying petrochemical transformation technologies shall be considered for the above mentioned branch. Therefore, before entering investment promotion action the Government of Indonesia asked UNIDO to carry out a comparative study of the development options. This report presents results of technical and economic assessment of the potential options.

The report provides analytical review of the development options of the oleochemicals and surfactants industry in Indonesia by the Year 2003/2004. Availability of the natural oils (palm oil, coconut oil and palm kernel oil) for the industrial use is given. Demand for local consumption as well as for export for 42 products has been estimated. Market study has been prepared by UNIDO experts Mr. J. Rouanet and S. Mercier who were on mission in Indonesia in the period between 4 October to 7 November 1992. They have visited Ministry of Industry, Ministry of Agriculture, Chemical Associations APROBASI, APOLIN, APKAPI, Indonesian Trade Statistics Bureau as well as ten industrial companies involved in the processing of natural oils into oleochemicals. Their report might be considered as a current market study with short-term range of projections.

The current statistical data have been collected with care and necessary comments on data credibility are given. The splits of products are detailed to the extent enabled by national statistics. The direction of the development trend has also been presented. The alternative proposals for the development of higher value added products have been given. The final data of this market study have been used and compared with data obtained by the macroeconomic analysis. Macroeconomic analysis has been provided comparing the potential of development of the chemical industry in Indonesia with other South-East Asian countries. To estimate the consumption pattern of the local market the simplified input-output analysis has been applied.

The consumption pattern of the surfactants and their precursors - oleochemicals, included following outlets:

- household consumption in the form of:
  - soaps
  - detergent powders
- major industrial uses of surfactants:
  - crude oil extraction industry
  - textile industry
  - pulp and paper industry
  - cosmetics industry
  - paints and lacquers industry
  - pesticides and fertilizer industry
  - rubber industry
  - plastic processing industry
  - food additives industry

Consumption of soaps and detergent powders is well correlated with the value of the GDP/capita. For the purpose of projection the GDP ihas been presented in purchasing power parity values.

For the purpose of exports projection evaluation three scenarios for raw materials have been developed:

- stable export amount (this is maximum investment scenario in the field of oleochemicals in Indonesia.). Scenario I.
- growth of exports at the rate 2 % per year. Scenario II.
- market share of Indonesia will remain constant. Scenario III. This is a minimum investment scenario.

Table A Projections of the raw materials availability by the year 2000

Products	CPO	PKO Kt/year	CNO	Total
Total available	3280	500	800	4580
Scenario I				
Export	1170	136	200	1506
Industrial use	2110	364	600	3074
Scenario II				
Export	1400	160	240	1800
Industrial use	1880	340	560	2780
Scenario III				
Export	1800	200	240	2240
Industrial use	1480	300	560	2340

Accordingly to the projections of Oil World by the year 2000 the worldwide consumption of natural oils will attain 105 million tons, from which 22 million tons would be palm and kernel oils and 5 million tons would be coconut oil. Therefore, in the projected maximum export scenario the Indonesian part will be 7.5% (present 9.1%) and 4.8% (present 4.7%) respectively. Indonesia will produce about 7% of natural oils supplied world wide by the year 2000, therefore can be considered as one of leading producers of natural oils. The comparative advantage of local market, allowing for establishment of higher capacity units and favorable economic conditions, highly populated markets of China, India, Pakistan, Bangladesh, Thailand etc. allow to predict that at active marketing strategy Indonesia can export about 100,000 t/year of surfactants and more than 300,000 t/year of oleochemicals. The more detailed projection of exports requires regional market study, which was not expected to be provided by this report.

By using the consumption and foreign trade data we can provide the following projection of the production profile of the oleochemicals and surfactants industry in Indonesia by the begin of the next millennium as a result of implementation of Repelita VI and Repelita VII development plants.

Table B Production projection of oleochemicals and surfactants by the year 2003/2004

Product	Apparent consumption	Export	Import	Production
	Kt/year [1/]			
Oleochemicals				
Fatty acid mix	30	150	-	180
Stearic acid	25	150	-	175
Oleic acid	15	150	-	165
Esters:	61.5	130		191.5
Methylesters	40	60	-	100
Butyl oleate	3	20	-	23
2,6-heksyl oleate	1	-	-	1
Butyl stearate	6	20	-	23
2.6-heksyl stearate	1	2	-	3
Lauryl glycol ether	2.5	10	-	12.5
Stearic glycol ester	2	4	-	6
Di-glycerol stearate	2	6	-	8
Polyglycerol stearate	2	4	-	6
Di-glycerol oleate	1	3	-	4
Polyglycerol oleate	1	1	-	2
Fatty alcohols	20	160	-	180
Fatty acid amides	2	20	-	40
Fatty acid amines	4	15	-	19
Soaps	520	250	-	770
Metallic soaps:	19	150	-	169
Aluminium Stearate	3	30	-	33
Magnesium Stearate	1.5	15	-	15
Zinc stearate	4.5	45	-	49.5
Barium stearate	4	40	-	44
Calcium stearate	6	25	-	31

Surfactants:

LABS	140	90	230
FAE	75	80	155
SLS	70	60	130
SLES	90	60	150
NPES	30	20	50
TEA lauryl sulfate	5	20	25

The concept of the technological network to describe the structure of the chemical industry has been used for analytical as well as for strategic purposes. The flow of products through the industrial structure induces from economic point of view value added, using different resources like energy, manpower, and equipment (in form of depreciation). The flow of chemicals reaches the final consumer in form of direct chemical products or in form of fabricated goods produced by other industries.

In such a case two potential routes to the final product exist:

1. a synthetic route, when all transformations originate from one of the hydrocarbons containing resources (crude oil, coal, natural gas);
2. a natural resources route, when all transformations originate from one of agro-products (sugar, starch, natural oils, cellulose, etc.).

The competitiveness of the transformation route depends on many factors and differs from country to country. In general the synthetic route is considered more reliable as it does not depend on prevailing climatic conditions in a given year. However, in countries with large proportion of population living in villages, the development of the industrial transformation of natural agro-products allows for more equitable growth of the GDP per capita in cities and villages.

1. Synthetic route

Oleochemicals

Synthetic route for oleochemicals has been found non-profitable. It was based on the extraction of paraffins from crude oil fractions, distillation of paraffins with later oxidation. As a result a mixture of acids and hydroxy acids is obtained of saturated character (synthetic stearic acid). Production of unsaturated acids is not practical at all. Some of fractions are cracked to obtain higher olefines used for alkylation purposes.

Linear alkylbenzene remains one of products in which technology are used synthetic hydrocarbons either from paraffines (alkylation of benzene by chloroparaffines) or from olefines originating from cracking (alkylation of benzene by higher olefines).

Also tetramer of propylene is used as an alkylating agent, however owing the non-biodegradability of branched products, use of these detergents is forbidden in many countries.

Glycerine - another product of natural fats and oils hydrolysis, is obtainable by synthetic route from propylene, through allyl chloride. The remaining transformations to the commercial products are similar to the natural oils and fats processing.

The technological network of synthetic oleochemicals is given on Fig. 1.

Surfactants.

Synthetic alcohols are produced by direct oligomerization of ethylene, or by hydroxidation of synthetic olefines. Etoxylation process uses ethylene or propylene oxide produced from ethylene and propylene by direct oxidation.

Natural route

Oleochemicals

All oleochemicals can be produced from natural oils. CNO and PKO are composed in large proportion from C12-C14 acids as well as contain oleic and linoleic acids. Palm oil contains palmitic acid which has less industrial applications and is used in soaps industry, however the high content of oleic acid makes it an interesting raw material for production of stearic acid (by hydrogenation) if the latter is not available form solid fats.

Glycerine is obtainable by hydrolysis and esterification. The latter process is more efficient and yields nearly 90% of glycerine.

Surfactants

Production of alcohols form natural acids is carried out by hydrogenation. Both, saturated alcohols and unsaturated alcohols can be obtained. The double bond in higher alcohols allows for all types of epoxydation and addition, making these products interesting for many chemical industry branches. The processing of natural alcohols is similar to synthetic ones. It is difficult to obtain pure identified substances from natural oils. However, the mixtures are perfectly performing their functions in surfactants industry.

The technological networks are given on flowsheets (Fig.2, Fig.3).

The investment programme has been analyzed in several options using original methodology of business opportunities selection.

Selection of the business opportunities to apply necessary industrial promotion policies and to issue investment concessions requires always the following basic steps necessary to ensure identification of appropriate business opportunities and promote the foreign investment:

i) Identification of the strategic goals and their definition in the measurable parameters (macroeconomic parametrization);
ii) A sectoral/subsectoral consumption projection based on macroeconomic individual patterns of consumption or on the Leontieff matrix in order to identify markets;

iii) Establishment of the technological network ensuring consumption needs of the final consumer commodities and goods, analytical evaluation of the network, optimization of the industrial structure giving certain scenarios of the constraints and finally selection of the priority investment projects.

iv) Simulation of the resulting structure efficiency under different packages of policies and risk analysis testing the impact of external variables like prices and demand changes.

A well integrated policies package will also serve as a motivation in other subsectors in following the given development pattern.

Methodology of the search for optimum set of business opportunities is given in Annex I to the main report body and in project proposal (PART II). The standard model is composed from balance equations, constraints and goal(s) functions. The following optional programmes have been researched:

(1) Implementation of the full production programme (the balance equations are showing the maximum demand) at the maximization of the profit using natural oils as a raw material. In this case all inefficient investments would be excluded from the production programme (Case MAXNAT).
Similar case but using synthetic materials (synthetic alcohols and synthetic glycerine) has been investigated to analyze difference between two routes (Case MAXSYNTH).

(2) Implementation of the limited production programme defined by the investment financial resources.
The selection of investment limits is arbitral, however it presents the most efficient production programme. The investment limit has been established at value of 30% of maximum programme (Case INVMIN). Alternative programme satisfying the local demand at limited investment has been also investigated (Case LOCSUP). The latter would correspond the import substitution strategy.

(3) The multiobjective goal function has been also investigated. In this case ratio profit over investment has been maximized as a goal function. To eliminate trivial case of "0" the expected investment expenditures in amount of US $ 1600 million has been introduced and maximum ratio has been searched on production function (Case RATIO).

The values of cost calculation policy parameters are given in the Annex III of the main report body and price list of raw materials and products (local and export values) are given in Annex IV. The list of technology sources is given in Annex V of the main report body.

Technological profiles of processing technologies have been elaborated to estimate investment and production cost. The list of the technological processes considered is attached. (Annex II of the main report body). The production programme in seven options differing in efficiency and investment expenditures have been provided and evaluated. The examples of policy measures impact on business opportunity selection have been presented. For the purpose of analytical evaluation software package MIDA has been used. The summary of results of simulation experiments is given in Table C.

Table C. Comparison of main results [in mill. USD]

	MAXNAT	MAXSYNTH	INVMIN	LOCSUP	RATIO	RISK	DEBT
PDA Yr Profit	1249	1081	606	547	844	550	732
PDA Val. Added	2097	1904	906	844	1305	984	1306
Investment	3044	3089	1000	998	1600	1600	1600
Yearly Import	226	206	83	95	114	114	114
Yearly Exp.	2337	1950	554	0	914	758	914
Prod. Value	6753	6302	2432	2247	3679	3729	3679

Development of the industrial subsector of oleochemicals and surfactants would be highly profitable in Indonesia either for the case of import substitution or export promotion strategy. The investment rate of about US $ 300 million per year is necessary to achieve during next ten years an adequate stage of development of oleochemicals and surfactants industry allowing consumption of available natural oils. Substantial part of high value added products is based on stearic acid, therefore large scale hydrogenation of oleic/linoleic acids should be considered if substantial amount of tallow is not available. This leads to specific processing line of fatty acids, combining by-products to produce high quality soaps.

Oleochemicals and surfactants have found application in formulated mixtures practically in all branches of industry, however necessary development of formulation and recipes of high quality additives limits their utilization. Without R&D capability accessible to the industry, local utilization of oleochemicals and surfactants is not possible on wide scale. Also marketing products for export requires availability of advisory specialized services which are not possible to get from small and medium scale industry.

The R&D Centre of oleochemicals and surfactants technology, formulation and application should be established as a joint venture of the Government and relevant Industry Association with the assistance of UNIDO. The activities of the Centre can be financed from raw materials levies. The detailed description of the concept and modalities of operation are given in the attached Project Document (Part III).

Conclusions and Recommendations

Conclusions

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2. Substantial part of high value added products is based on stearic acid, therefore large scale hydrogenation of oleic/linoleic acids should be considered if substantial amount of tallow is not available. This leads to specific processing line of fatty acids, combining by-products to produce high quality soaps.

3. Oleochemicals and surfactants have found application in formulated mixtures practically in all branches of industry, however necessity of formulation, development and elaboration of recipes for high quality additives limits their utilization. Without R&D capability accessible to the industry, oleochemicals and surfactants local utilization on wide scale is not possible. Also marketing products for export requires availability of advisory specialized services which are not possible to get from small and medium scale industry.

4. Continuous adjustment of the development programme and business opportunities promotion adequate to the range of investment requires implementation of decision support systems, and this option has been presented in the report.

Recommendations

1. The proposed export programme should be tested in regional Asia-Pacific market study. In particular China should be considered as a potential market.

2. The R&D Centre of oleochemicals and surfactants technology, formulation and application should be established as a joint venture of the Government and relevant Industry Association with the assistance of UNIDO. The activities of the Centre can be financed from raw materials levies. The detailed description of the concept and modalities of operation are given in the attached Project Document (Part III).

3. Feasibility studies for a number of projects should be prepared as future risks related to the price or demand decrease seems to be very limited. Selection of projects for feasibility studies should be based on well established methodology of the business opportunities selection. Modalities of the know how transfer to the Ministry of Industry staff and Industrial Association have been presented in the attached Project Document (Part II).

Abstract

The report provides an analytical review of the development options of the oleochemicals and surfactants industry in Indonesia by the Year 2003/2004. Availability of natural oils (palm oil, coconut oil and palm kernel oil) for the industrial use is given. Demand for local consumption as well as for export for 42 products has been estimated.Technological profiles of processing technologies have been elaborated to estimate investment and production cost. Seven options of the production programme differing in efficiency and investment expenditures have been provided and evaluated. The examples of policy measures impact on business opportunity selection has been presented. For analytical evaluation software package MIDA has been used.

Development of the industrial subsector of oleochemicals and surfactants can be highly profitable in Indonesia either in the case of import substitution or export promotion strategy. The investment rate of about US $ 300 million per year is necessary to achieve during next ten years adequate stage of development of oleochemicals and surfactants industry allowing consumption of available natural oils. Substantial part of high value added products is based on stearic acid, therefore large scale hydrogenation of oleic/linoleic acids should be considered if substantial amount of tallow is not available. This leads to specific processing line of fatty acids, combining by-products to produce high quality soaps.

Oleochemicals and surfactants have found application in formulated mixtures practically in all branches of industry, however need of formulation development and elaboration of recipes for high quality additives limits their utilization. Without R&D capacities accessible for industry, local utilization of oleochemicals and surfactants on wide scale is not possible. Also products marketing for export requires availability of specialized advisory services which are not possible to get from small and medium scale industry.

The R&D Centre for oleochemicals and surfactants technology, formulation and application should be established as a joint venture of Government and relevant Industry Association with the assistance from UNIDO. The activities of the Centre can be financed from raw materials levies. The detailed description of the concept and modalities of operation are given in the attached Project Document.

Continuous adjustment of the development programme and business opportunities promotion adequate to the range of investment is indispensable. It requires implementation of decision support systems, and this option has been presented in the report.

Feasibility studies for a number of projects should be prepared as future risks related to price or demand decreases seem to be very low. Selection of projects for feasibility studies should be based on well established methodology of business opportunities selection. Modalities of the know how transfer to the Ministry of Industry staff and Industrial Association have been presented in the attached Project Document.

The proposed export programme should be tested in regional Asia-Pacific market study. In particular China should be considered as a potential market.

Introduction

Indonesia is one of the South-East Asian countries becoming a candidate to the group of NICs (Newly Industrialized Countries). The country fulfils all necessary conditions for industrial development and among its assets following can be enumerated:

- large scale local market allowing for establishment of economic size installations;
- abundance of hydrocarbon resources;
- abundance of natural resources of agricultural origin;
- stable and advantageous economic system attracting foreign investments;
- satisfactory infrastructure and especially established banking system.

However, this "embarrass de richesse" poses high responsibility on shoulders of decision makers. The options for development are not obvious, and selection of investment projects priorities requires numerous studies and unbiased assessment. On one hand it could be advantageous to follow the established way of development of the petrochemical industry and add more value to the hydrocarbon resources. However, on the other hand agriculture employs over 50% of the population and introduction of agro-products processing industrial structure may have positive impact on increase of farmers income as well as on the industrialization process. The selection of the most advantageous option is also important from the point of view of international competition.

The export promotion strategy initiated in 1983 may bring positive results in the long term only when commodities will be produced accordingly to the technology that is modern and competitive in terms of used raw material and manpower costs.

One obvious candidate for project selection priority exercise is the branch of surfactants and detergents. All the natural raw materials occur in Indonesia and they could be processed to high value added products bound for local consumption and export. However, other development line results in the area of the petrochemical industry. Therefore, before entering investment promotion action the Government of Indonesia asked UNIDO to carry out a comparative study of the development options. This report presents results of technical and economic assessment of the potential options.

I. MACROECONOMIC POSITION OF THE REPUBLIC OF INDONESIA

This review is based on statistical data available in UNIDO and in particular on the Global Report 1992/1993 with the task to provide data for development projection. Obviously, it has no ambition to cover all aspects of the Indonesian economy.

The Indonesian development strategy, similarly to those of many of South-East Asian (SEA) countries, was oriented mainly towards import substitution. In the 70-ties Indonesia denoted high rate of the economic growth that was largely fuelled by crude oil extraction and exports.

Just before 1980 the oil sector contributed about one quarter of GDP, over 60% of Government revenues and about 80% of merchandise export. However, owing to the following oil price decrease and rapid growth of interest rates the cost of debt service increased quickly and negative growth has been recorded. Following the drastic policy measures like devaluation of rupiah, cutting subsidies and postponing the development projects and liberalisation of foreign trade, equilibrium of economy has been regained and in 1985 positive GDP growth was restored. Important reforms have been enacted in taxation and other financial fields. However, in 1986 oil prices dropped again and the US dollar was depreciated against other major currencies which aggravated Indonesia's debt service problem. Again policy measures have been undertaken, like rupiah devaluation, Government budget cuts and positive change to export promotion policy has been denoted. In 1987 export bans and quotas as well as import control of about 400 commodities has been removed and abolishment of export licences was undertaken. Also positive changes were enacted in the investment law, promoting capital inflow. During last years slight economic growth (over 6% per year) in Indonesia may be observed, due to increasing investment in Indonesia in the field of textile and civil construction. The low cost and abundant supply of labour in Indonesia are attracting investment in labour oriented industries such as textiles.

Having in mind that any macroeconomic data have value if related to similar parameters of other countries, below information is given for several SEA countries.

Historical trend of the results of the export oriented strategy of development applied in SEA countries is given below in Table 1:

Table 1 Economy transformation features in SEA countries

Country	GDP growth (1965-1990) % per year	Contribution of industry to GDP in %		Ratio in world exports %		Trade balance US $ million	
		1978	1990	1978	1990	1975	1990
Indonesia	**6.3**	**9**	**14**	**0.03**	**0.24**	**2333**	**5969**
Korea Rep.	9.3	24	30	0.78	1.97	-2193	8885
Malaysia	6.6	17	19	0.18	0.37	277	4559
Philippines	4.1	25	25	0.12	0.21	-1482	-1696
Thailand	6.7	18	21	0.11	0.27	- 903	-3499
Taiwan Pr.	9.0	38	43	0.87	1.95	- 643	10739

Source: Global report UNIDO 1992/1993
UNCTAD Handbook of International Trade and Development Statistics, New York 1991

The data indicate healthy economic growth and efficiency of export promotion strategies. Indonesia still has a low contribution of industry to GDP and lower than expected ratio in world export.

The current (1990) economic situation is given in Table 2.

Table 2 Macroeconomic features of the SEA countries development (1990)

Country	Population mln	GDP per capita US $	MVA(3) per capita US $	Ratio of export to GDP %	Ratio of investment to GDP %
Indonesia	**180.5**	**728**	**70**	**6.9**	**36.9**
Korea Rep.	43.6	3559	2103	35.9	37.0
Malaysia	17.2	2422	510	22.6	32.3
Philippines	62.5	670	116	10.1	22.5
Thailand	55.6	1221	427	9.0	36.8
Taiwan Pr.	20.3	4277	2730	50.8	22.4

Source: Global report UNIDO 1992/1993
Macroeconomic Structural Issues in the Asia-Pacific Economies

Indonesia among the SEA countries has largest population, nearly equal to the total of other mentioned countries and nearly lowest GDP per capita and manufacturing value added. However, owing to the needs of export promotion, rupiah is undervaluated and GDP per capita in terms of purchasing parity power (PPP) is about 3 times higher than in terms of official exchange rate. Similar situation was observed in Korea Rep. and Taiwan Pr. in early 70-ties. Large share of investment in the GDP and economic growth rate show that Indonesia takes part in competition to become the next NIC in the region.

It is obvious that strategy of development imposed certain pattern on selection of the technologies. Countries with high rate of manufacturing export must aim at introducing the advanced technologies. The qualitative assessment of the features in technology status quo in SEA countries is given in the Table 3.

Table 3 Technology development level in SEA countries

Country	Technology pattern			
	Raw materials oriented	Labour oriented	Capital oriented	Science oriented
Indonesia	**++**	**++**	**+**	**-**
Korea Rep.	-	+	++	++
Malaysia	+	++	+	+
Philippines	+	+++	+	-
Thailand	+	+++	+	-
Taiwan Pr.	-	+	++	++

Source: Global Report UNIDO 1992/1993
Macroeconomic Structural Issues in the Asia-Pacific Economies

Remark: Number of positive signs shows intensity of the technology applied

Following the world economic situation it is very difficult to forecast future development of economies in SEA countries. However, taking into account large scale Asian market, local natural resources one can project positive growth of economies in SEA countries and in particular in Indonesia.

The macroeconomic projection of the development by the year 2000 is given in table 4.

Table 4 Macroeconomic projection of the SEA countries development by the year 2000.

Country	GDP growth % per year	Population growth % per year	GDP per capita US $ a/	MVA (3) per capita US $ b/
Indonesia	**6**	**1.5**	**1128**	**270**
Korea Rep.	7	1.1	6280	4000
Malaysia	7	2.1	3847	1000
Philippines	5	1.9	903	225
Thailand	8	3.8	1820	800
Taivan Pr.	6	1.3	6702	4600

Source: Global report UNIDO 1992/1993 and own consultants' calculations

Remark: a/ in 1980 prices b/ in 1990 prices

Following targets of industrial development may be distinguished for Indonesia for the 90-ties:

- to overpass the level of US $ 1200 of GDP per capita;
- to increase the export ratio to GDP to 15%-18%;
- to increase the ratio of manufactured products in total export to 55%-65%;

The parallel usage of agricultural and mineral resources should be promoted taking into account importance of the agro-industries for well-being of over 70% of population as well as the price dumping of petrochemical products on SEA countries markets by industrialized world.

The particular figures in tables are given in values obtained through recalculation from national currency using official rate of exchange. However, for some countries, especially in South-East Asia, the GDP expressed in US $ and derived from Purchasing Power Parity (PPP) is much higher than expressed in terms of official rate of exchange. This phenomenon is observed in cases when export promotion policies lead to under evaluation of local currency and according to social policies of Government, prices of food, energy, etc. reflect in a realistic way purchasing power of the society. Below are given the data for SEA countries taking into account PPP as a multiplier.

Table 5 GDP value of SEA countries in terms of PPP (1992)

Country	GDP in US $ billion at rate of exchange value	at PPP value	Difference in %
Indonesia	**120**	**510**	**425**
Korea Rep.	300	380	127
Malaysia	54	130	241
Philippines	53	155	292
Thailand	102	320	314

Source: World Economic Outlook, IMF 1993

The projections of local consumption should be rather correlated to the PPP equivalent because prevailing statistical data of industrialized countries are given in PPP values, which in their cases are nearly equal to the values received through rate of exchange.

II. CHEMICAL INDUSTRY IN THE REPUBLIC OF INDONESIA

Chemical industry in SEA countries and in Indonesia in particular is not considered a locomotive of development.
All countries denote large deficit in the trade of chemicals and production per capita is lower than expected taking into account GDP per capita level. The chemical industry in SEA countries has been established through:

- investments promoted and sponsored by the Governments;
- joint-venture investments;
- endogenous investment from trade capital savings.

The basic features of the chemical industry in SEA countries are given in Table 6.

Table 6 The pattern of the chemical industry in SEA countries (1990) a/

Country	MVA (351+352) ratio in manufacturing in %	MVA (351+352) per capita in US $	Export per capita SITC 5 US $	Import per capita SITC 5 US $	Trade balance SITC 5 US $ M
Indonesia	**7.6**	**5.3**	**1.2**	**11.3**	**-1789**
Korea Rep.	8.8	185.5	26.4	86.2	-3291
Malaysia	11.3	57.5	12.2	56.5	- 798
Philippines	13.1	15.2	2.8	12.1	- 868
Thailand	8.0	4.7	1.9	24.8	-1692
Taiwan Pr.	9.7	264.2	67.7	181.1	-2301

Source: Global report UNIDO 1992/1993 and own consultants' calculations
Remark: a/ in current prices

Indonesia has clearly underdeveloped chemical industry and taking into account that all modern products are composed or connected in production process with consumption of chemicals the need for the strong Government promotion of this industry is obvious and urgent.

The weakness of the chemical industry in Indonesia can be illustrated also by the structural composition of this industry. The SEA countries data are given in table 7.

Table 7 Chemical industry structure in SEA countries

Countries	351	352	353	354	355	356
	Chapters of SITC in % of the total chapter SITC 35					
Indonesia	**15.9**	**15.0**	**55.9**	**.**	**9.1**	**1.1**
Korea Rep.	22.3	25.1	18.9	5.1	16.1	12.5
Malaysia	49.8	12.1	11.0	1.6	18.1	7.4
Philippines	12.7	21.1	58.9	0.1	4.4	2.8
Thailand	14.4	31.1	30.9	1.9	14.2	7.5
Taiwan Pr.	22.9	24.4	40.1	0.6	4.6	2.4

Source: Global report UNIDO 1992/1993 and own consultants' calculations

To adjust structure of chemical industry to the pattern (351) 19%, (352) 20%, (353) 43%, (355) 11% and (356) 8% which may be considered as adequate to the level of Indonesian economy development, it would be necessary to invest about US $ 1,750 million.

The performance of the chemical industry and consumption of selected groups of chemicals in the SEA countries and in particular in Indonesia is given in table 8. The short description of the methodology of projections by the year 2000 is given in the Annex I.

Table 8 Performance of the chemical industry in SEA countries

Variables	Unit	SEA 1990	SEA 2000	Indonesia 1990	Indonesia 2000	% by the year 2000
Production:						
- ethylene	Kt		6200		550	8.9
- propylene	Kt		3000		300	10.0
- benzene	Kt		2000		120	6.0
- p-xylene	Kt		2000		270	13.0
- PE	Kt	2100	4300	-	700	16.3
- PP	Kt	1300	2700	20	345	12.8
- PS	Kt	1200	1700	23	53	3.2
- PVC	Kt	2350	2850	175	215	7.5

Table 9 Performance of the chemical industry in SEA countries (continued)

Variables	Unit	SEA 1990	SEA 2000	Indonesia 1990	Indonesia 2000	% by the year 2000
Consumption:						
- detergents						
-- kg/capita			5.6	3.0	4.0	-
-- Kt			2600	540	850	32.7
- cosmetics						
-- US $/capita				18.2	22.5	-
-- Kt			12500	3700	4600	36.7
- paints & la[illegible]s						
-- kg/capita				0.8	3.0	-
-- Kt			2950	144	630	21.4
- engineering plastics						
-- kg/capita				0.1	0.3	-
-- Kt			1220	18	65	5.3
- paper additives						
-- Kt		210	400	23	61	15.3
- textile additives						
-- Kt		970	1052	127	270	25.7

These data are showing expected development direction in a quantitative way by the year 2000. To develop packages of industrial policies active for a longer period of time a qualitative assessment of the options in each branch of industry is necessary as well as consideration of constraints of development. The combined matrix may show the priority areas as well as add to the selection of package of policies supporting the development of the oleochemicals industry at later stage of this analysis. The options and constraints are given in following tables.

Table 10 Options of the chemical industry development in SEA countries

Products Countries	HTP	EP	SF	SUR	P&L	PCh	TCh
Indonesia	+++	+	++	+++	+	+	+
Korea Rep.	+++	++	+	++	+++	++	+
Malaysia	+	++	+	+++	+	++	++
Philippines	-	-	+	++	+	-	-
Thailand	++	-	+	+	++	++	+++
Taiwan Pr.	+++	+++	++	+	+++	++	+

Source: Global report UNIDO 1992/1993
Macroeconomic Structural Issues in the Asia-Pacific Economies

Table 11 Constraints of the chemical industry development in SEA countries

Constraints Countries	PS	IS	LE	LCE	E&TL	FCP	EC	DS
Indonesia	**+**	**++**	**-**	**++**	**+**	**+**	**+**	**+**
Korea Rep.	+	+++	+	++	++	+	++	++
Malaysia	++	++	-	-	+	++	+	-
Philippines	-	-	-	-	+	+	-	-
Thailand	+	++	-	-	+	+	-	+
Taiwan Pr.	+++	+++	++	++	+++	+++	++	-

Source: Global report UNIDO 1992/1993
Macroeconomic Structural Issues in the Asia-Pacific Economies

III. REVIEW OF THE MARKET STUDY ON OLEOCHEMICALS AND SURFACTANTS

A. Evaluation of the experts findings

UNIDO experts Mr. J. Rouanet and S. Mercier have been on mission in Indonesia in the period between 4 October to 7 November 1993. They have visited Ministry of Industry, Ministry of Agriculture, Chemical Associations APROBASI, APOLIN, APKAPI, Indonesian Trade Statistics Bureau as well as ten industrial companies involved in the processing of natural oils into oleochemicals.

Their presented report might be considered as a current market study with short-term range of projections. The statistical current data have been collected with care and necessary comments on data credibility are given. The splits of products are detailed to the extent enabled by national statistics. However, input-output analysis (even by values), if given, would be more indicative on types of products expected to grow in future years. The direction of the development trnd has been also presented (without time series analysis), however the projection time (1995) has been taken too short to consider practical investment undertaking as well as to prepare the R&D programme and proposals for foreign investors.

The alternative proposals for the development of higher value added products have been given, however selection of lines of development has not been supported by any comparative model calculations. The final data of this market study will be used and compared with data obtained by the macroeconomic analysis.

1. Availability of the raw materials

Indonesia produces palm oil, palm kernel oil and coconut oil. The historical data on the production are given in table 12.

Table 12 Historical data on natural oils production

Years Products	1980	1985 Kt/year	1991
Crude palm oil (CPO)	720	1210	2600
Palm kernel oil (PKO)	126	260	260
Coconut oil (CNO)	830	900	1100

Source: EIU Country Report 1990
UNIDO experts' report 1992

Consumption of the oils in 1991 is as follows:

Table 13 Apparent consumption of natural oils (1991)

Products	CPO	PKO Kt/year	CNO	Total
Production	2600	260	1100	3960
Import	38	17	7	62
Export	1168	136	198	1502
Apparent consumption	1470	141	909	2520

Source: UNIDO experts report 1992

The prices of natural oils are unstable and depend on annual crops in all producing countries as well as on other natural oils world production (e.g.soya oil, sunflower oil, etc.) and may change monthly by 50%-80%.

Table 14 Palm oil prices changes

Years	1986	1987	1988 US $/t	1990	1991	1992
Palm oil	190(VIII)	390(XII)	500(I)	343(III)	285(Av.)	331

Source: EIU Country Report (1998)
Chemical Marketing Reporter (March 1990)
UNIDO experts' report

Coconut oil is traditionally more expensive by 30%.

The domestic consumption of natural oils in 1991 has been divided between food and cooking (72%) and industrial uses (28%).

Production projections of the natural oils are based on the acreage of the palms and age of plantations. Actually the production capacities accordingly to the Ministry of Agriculture would allow following production of oils:

Table 15 Natural oils production capacities

Years Products	1991	1992	1993	1994 Kt/year	1995	Full capacity
CPO	2600	3200	4000	4800	5500	4800
PKO	260	320	400	480	550	480 (960)
CNO	1100	1300	1350	1450	1550	3200

Source: UNIDO experts report

The full production capacity takes into account the actual acreage of plantations and average yields. In case of PKO the yields may reach 960 Kt/year if export of kernels would be stopped.

For the purpose of conservative projection by the year 2000 we would use the following figures of available natural oils:

- CPO 4800 Kt/year
- PKO 600 Kt/year 1/
- CNO 1600 Kt/year 2/

1/ unsatisfactory recovery still considered
2/ 50% of the CNO is consumed by producers without reaching market

This amount will be distributed as follows:

Table 16 Projection of natural oils consumption distribution by the year 2000

Products	CPO	PKO	CNO	Total	
		Kt/year			
Production	4800	600	1600	7000	
Food & cooking	1520	100	800	2420	
Export & ind.	3280	500		800	4580

Source: JSRD experts' own calculations

At present (1991) the food & cooking use of oils has been recorded at the level of 1800 Kt/year. Taking into account Indonesian population growth as well as projected GDP/capita growth it has been projected that 3% annual growth of the food & cooking consumption pattern (from 1800 Kt/year to total 2420 Kt/year by the year 2000) will occur.

The split of oils consumption distribution is hypothetical. It is acknowledged that PKO and CNO have higher prices and their fatty acids composition is much more favorable for the industrial use. Therefore, in the next chapters the policy measures would be discussed to promote local consumption by food and cooking application CPO and industrial use of PKO and CNO. On the other hand the high content of unsaturated acids (oleic an linolenic) in the palm oil makes it more healthy for human consumption.

For the purpose of exports projection evaluation three scenarios have been developed:

- stable export amount (this is maximum investment scenario in the field of oleochemicals in Indonesia.). Scenario I.
- growth of exports at the rate 2 % per year. Scenario II.
- market share of Indonesia will remain constant. Scenario III. This is a minimum investment scenario.

The results of calculation are given in the table below:

Table 17 Projections of the natural oils exports by the year 2000

Products	CPO	PKO	CNO	Total
		Kt/year		
Total available	3280	500	800	4580
Scenario I				
Export	1170	136	200	1506
Industrial use	2110	364	600	3074
Scenario II				
Export	1400	160	240	1800

Industrial use	1380	340	560	2780
Scenario III				
Export	1800	200	240	2240
Industrial use	1480	300	560	2340

Source: Own JSRD experts' projections

Accordingly to the projections of the Oil World by the year 2000 the worldwide consumption of natural oils will attain 105 million tons, of which 22 million tons would be palm and kernel oils and 5 million tons would be coconut oil. Therefore, in projected maximum export scenario Indonesian share will be respectively 7.5% (present 9.1%) and 4.8% (present 4.7%).

Therefore, availability of oleo-raw materials structured by useful fractions for industrial purposes would be for all three scenarios as follows:

Table 18 Structure of oleo-raw materials by the year 2000

Fractions	Scenario I	II	III
	Kt/year		
Saturated:			
C_8-C_{10}	100	95	90
C_{12}	480	450	430
C_{14}-C_{15}	175	160	150
C_{16}	980	880	690
C_{18}	85	75	60
Unsaturated:			
C_{18}-oleic	940	830	675
C_{18}-linoleic	210	190	150

Source: Own JSRD experts' calculations

At present oleochemicals and surfactants industry operates in Indonesia. The amount of produced oleochemicals in 1991 and capacities of nearly to completion installations (1993/1994) are given in the following table:

Table 19 Apparent consumption of oleochemicals in Indonesia by the year 1994

Products	Production	Import	Export	Apparent consumption
		Kt/year		
Non-hydrogenated fatty acids	150	0.8	80	70.8
Stearic acid	104	0.2	80	24.2
Methylesters	20	-	15	5
Fatty alcohols	138	1.7	12	127.7
Toilet soaps	327	1.5	20	308.5
Other soaps	290	0.3	23	267.3
Metallic soaps	110	-	-	110(?)
Glycerin	99	5	8	96
Total	1238	9.5	238	1009.5

Source: Integrated table of UNIDO experts' report

Utilizing above raw materials and imported inputs the following surfactants are produced in Indonesia:

Table 20 Apparent consumption of surfactants in Indonesia (1991)

Products	Capacity	Production Kt/year	Import	Export	Apparent consumption
Alkylbenzene	120	90	-	-	90
ABS	96.6	66	2	2	66
SLS	17.2	11.7	0.8	10.3	2.2
Etoxylates	41.1	21	7.2	-	29.2

Source: Integrated table of UNIDO experts' report

Alkylbenzene is produced using propylene tetramer but from 1994 new installation would be operational producing alpha olefines from n-paraffins.

There is an obvious unbalance between products in table 16 (by the year 1994) and table 17 (by the year 1991) what means that oleochemicals are used in other branches of industries above the surfactants production. Their consumption pattern has not been identified in the report of UNIDO experts.

B. Macroeconomic consumption projection

Discussed above features of the Indonesian industry of oleochemicals and surfactants give good insight into the present industry development, however it is not possible to utilize these data to prepare projection of adequate structure of this industry for national consumption efficient satisfaction.

Therefore, other instruments have to be used to analyze optimum structure of this industry by the year 2000 to allow Government to apply necessary policy measures during the last in this millennium national plan e.g. Repelita VI.

The consumption pattern of the surfactants and their precursors - oleochemicals, should consider following outlets:

- consumption by the population in form:
  -- of soaps
  -- detergents' powders
- major industrial uses of surfactants:
  -- crude oil extraction industry
  -- textile industry
  -- pulp and paper industry
  -- cosmetics industry
  -- paints and lacquers industry
  -- pesticides and fertilizers industry
  -- rubber industry
  -- plastic processing industry
  -- food additives industry

Consumption of soaps and detergent powders is well correlated with the value of the GDP/capita. For the purpose of projection the GDP will be given in purchasing power parity (PPP) values.

Table 21 Household consumption of surfactants projection

Product	Consumption kg/capita 1992	Consumption kg/capita 2000	Consumption Kt/year 1992	Consumption Kt/year 2000
Soaps	2.3	2.5	420	520
Powders	1.3	4.0	240	832
Shampoos	0.5	0.7	90	146

Source: Experts data and consultants' own calculations

The projection of the consumption in relation to the GDP/capita is based on statistical data of 37 countries of different level of economical development.

The industrial consumption depends on the development of given branch of industries and its chances for development in future years. Therefore, the most reliable projection of input material consumption is that related to the MVA of given industrial branch. The ideal situation would be if input-output tables would be available for these branches of industries for the year 1990, however this is not a case of Indonesia.

Table 22 Projection of the consumption of oleochemicals and surfactants in Indonesia (without soaps)

Branch SITC	MVA/capita US $ 1990	MVA/capita US $ 2000	MVA 2000	Consumption of surfactants kg/US $ by year 2000	Consumption of surfactants Kt/year by year 2000
(311)	4.2	15.0	3120	0.007	22
(321+323)	5.0	11.0	2288	0.029	66
(341+342)	1.2	4.0	832	0.026	22
(351+352)	5.3	12.0	2496	0.17	420
(355)	.	.	.	.	50
(356)	.	.	.	.	15
Crude oil extraction		.	.	.	5
Total					600

Source: UNIDO Global Report 1992/1993 and own consultants' calculations

To establish a production forecast elaboration of the foreign trade projection is necessary. The foreign trade projections are very difficult to made, because the decisions of thousands of investors are not known beforehand, as well as the export success depends on marketing strategy and efforts, much more than can emerge from perfectly prepared market study.

In general at present around 900,000 t/year of surfactants and about 2,200,000 t/year of oleochemicals are traded on the world market. Indonesia will produce about 7% of natural oils supplied world wide by the year 2000, therefore can be considered as one of leading producers of natural oils. The comparative advantage of local market, allowing for establishment of higher capacity units and favorable economic conditions, highly populated markets of China, India, Pakistan, Bangladesh, Thailand etc. allow to predict that at active marketing strategy Indonesia can export about 100,000 t/year of surfactants and more than 300,000 t/year of oleochemicals. The more detailed projection of exports requires regional market study, which was not expected to be provided by this report.

By using the consumption and foreign trade data we can provide the following projection of the production profile of the oleochemicals and surfactants industry in Indonesia by the beginning of the next millennium as a result of implementation of Repelita VI and Repelita VII national development plans.

Table 23 Production projection of oleochemicals and surfactants by the year 2003/2004

Product	Apparent consumption	Export	Import	Production
	Kt/year 1/			
Oleochemicals				
Fatty acid mix	30	150	-	180
Stearic acid	25	150	-	175
Oleic acid	15	150	-	165
Esters:	61.5	130		191.5
Methylesters	40	60	-	100
Butyl oleate	3	20	-	23
2,6-heksyl oleate	1	-	-	1
Butyl stearate	6	20	-	23
2.6-heksyl stearate	1	2	-	3
Lauryl glycol ether	2.5	10	-	12.5
Stearic glycol ester	2	4	-	6
Di-glycerol stearate	2	6	-	8
Polyglycerol stearate	2	4	-	6
Di-glycerol oleate	1	3	-	4
Polyglycerol oleate	1	1	-	2
Fatty alcohols	20	160	-	180
Fatty acid amides	2	20	-	40
Fatty acid amines	4	15	-	19
Soaps	520	250	-	770
Metallic soaps:	19	150	-	169
Aluminium Stearate	3	30	-	33
Magnesium Stearate	1.5	15	-	15
Zinc stearate	4.5	45	-	49.5
Barium stearate	4	40	-	44
Calcium stearate	6	25	-	31
Surfactants:				
LABS	140	90		230
FAE	75	80		155
SLS	70	60		130
SLES	90	60		150
NPES	30	20		50
TEA lauryl sulfate	5	20		25

IV. DEVELOPMENT PROGRAMME OF THE OLEOCHEMICALS AND SURFACTANTS INDUSTRY

A. Structure of the oleochemicals and surfactants industry

The concept of the technological network to describe the structure of the chemical industry is used for analytical as well as for strategic purposes. The flow of products through the industrial structure induces from economic point of view value added, using different resources like energy, manpower, and equipment (in form of depreciation). The flow of chemicals reaches the final consumer in form of direct chemical products or in form of fabricated goods produced by other industries.

In a majority of cases two potential routes to the final product exist:

- a synthetic route, when all transformations originate from one of the hydrocarbons containing resources (crude oil, coal, natural gas);

- natural resources route, when all transformations originate from one of agro-products (sugar, starch, natural oils, cellulose, etc.).

The competitiveness of the transformation route depends on many factors and differs from country to country. In general synthetic route is considered more reliable as it does not depend on prevailing climatic conditions in a given year. However, in countries with large proportion of the population living in villages, the development of the industrial transformation of natural agro-products allows for more equitable growth of the GDP per capita in cities and villages.

1. Synthetic route

1.1 Oleochemicals

Synthetic route for oleochemicals has been found non-profitable. It was based on the extraction of paraffins from crude oil fractions, distillation of paraffins with later oxidation. As a result a mixture of acids and hydroxy acids is obtained of saturated character (synthetic stearic acid). Production of unsaturated acids is not practical at all. Some of fractions are cracked to obtain higher olefines used for alkylation purposes.

Linear alkylbenzene remains one of products in which technology are used synthetic hydrocarbons either from paraffins (alkylation of benzene by chloroparafines) or from olefines originating from cracking (alkylation of benzene by higher olefines). Also tetramer of propylene is used as alkylating agent, however owing the non-biodegradability of branched products, use of these detergents is forbidden in many countries.

Glycerine - another product of natural fats and oils hydrolysis, is obtainable by synthetic route from propylene, through allyl chloride. The remaining transformations to the commercial products are similar to the natural oils and fats processing.

The technological network of synthetic oleochemicals is given on Fig. 1.

1.2 Surfactants.

Synthetic alcohols are produced by direct oligomerization of ethylene, or by hydroxidation of synthetic olefines. Etoxylation process uses ethylene or propylene oxide produced from ethylene and propylene by direct oxidation.

2. Natural route

2.1 Oleochemicals

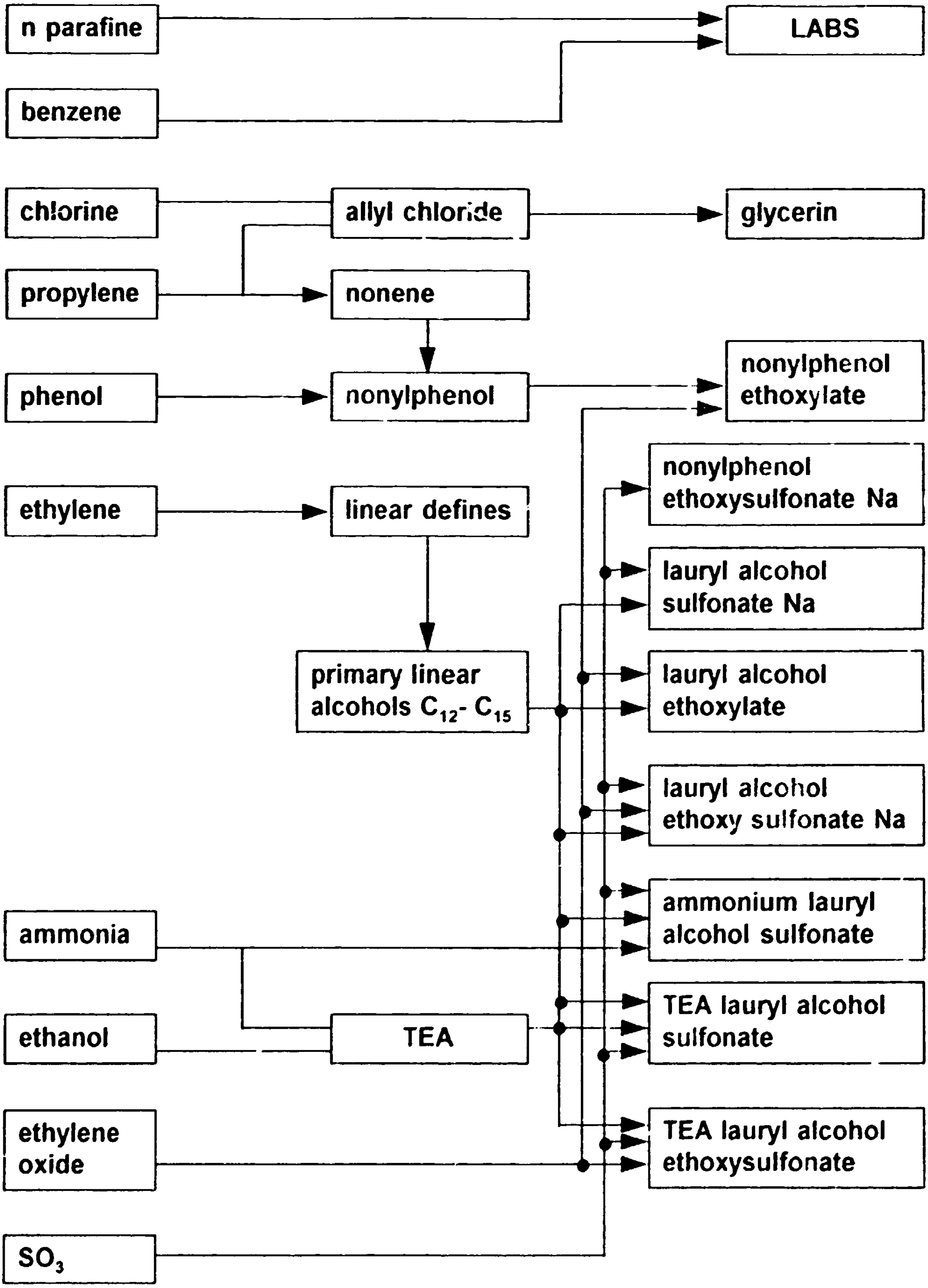
All oleochemicals can be produced from natural oils. CNO and PKO are composed in large proportion from C12-C14 acids as well as contain oleic and linoleic acids. Palm oil contains palmitic acid which has less industrial applications and is used in soaps industry, however the high content of oleic acid makes it an interesting raw material for production of stearic acid through hydrogenation if the latter is not available form solid fats.

Glycerine is obtainable by hydrolysis and esterification. The latter process is more efficient and yields nearly 90% of glycerine.

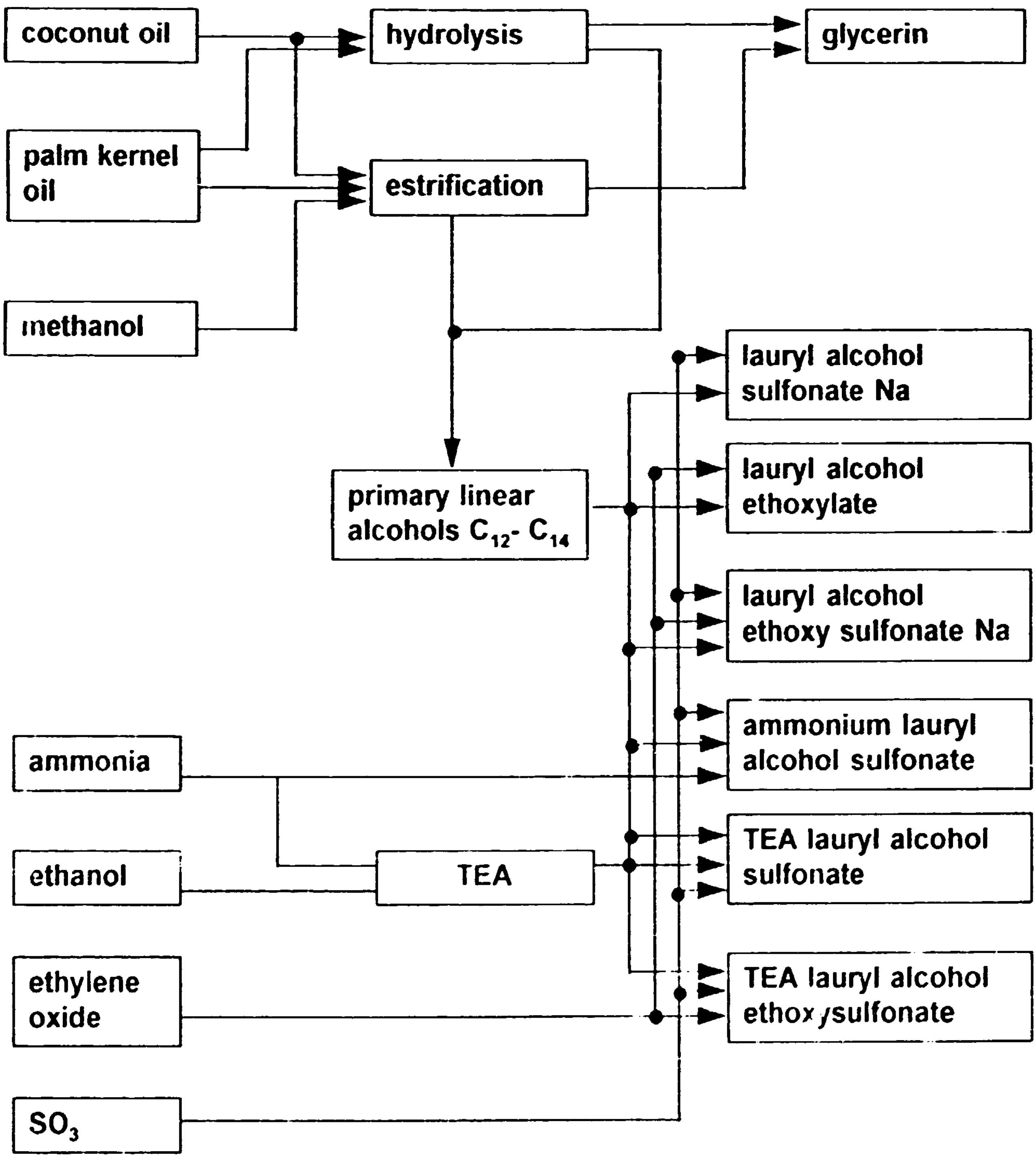
2.2 Surfactants

Production of alcohols from natural acids is carried out by hydrogenation. Both, saturated alcohols and unsaturated alcohols can be obtained. The double bond in higher alcohols allows for all types of epoxydation and addition making these products interesting for many chemical industry branches. The processing of natural alcohols is similar to synthetic ones. It is difficult to obtain pure identified substances from natural oils. However, the mixtures are perfectly operating in surfactant industry.

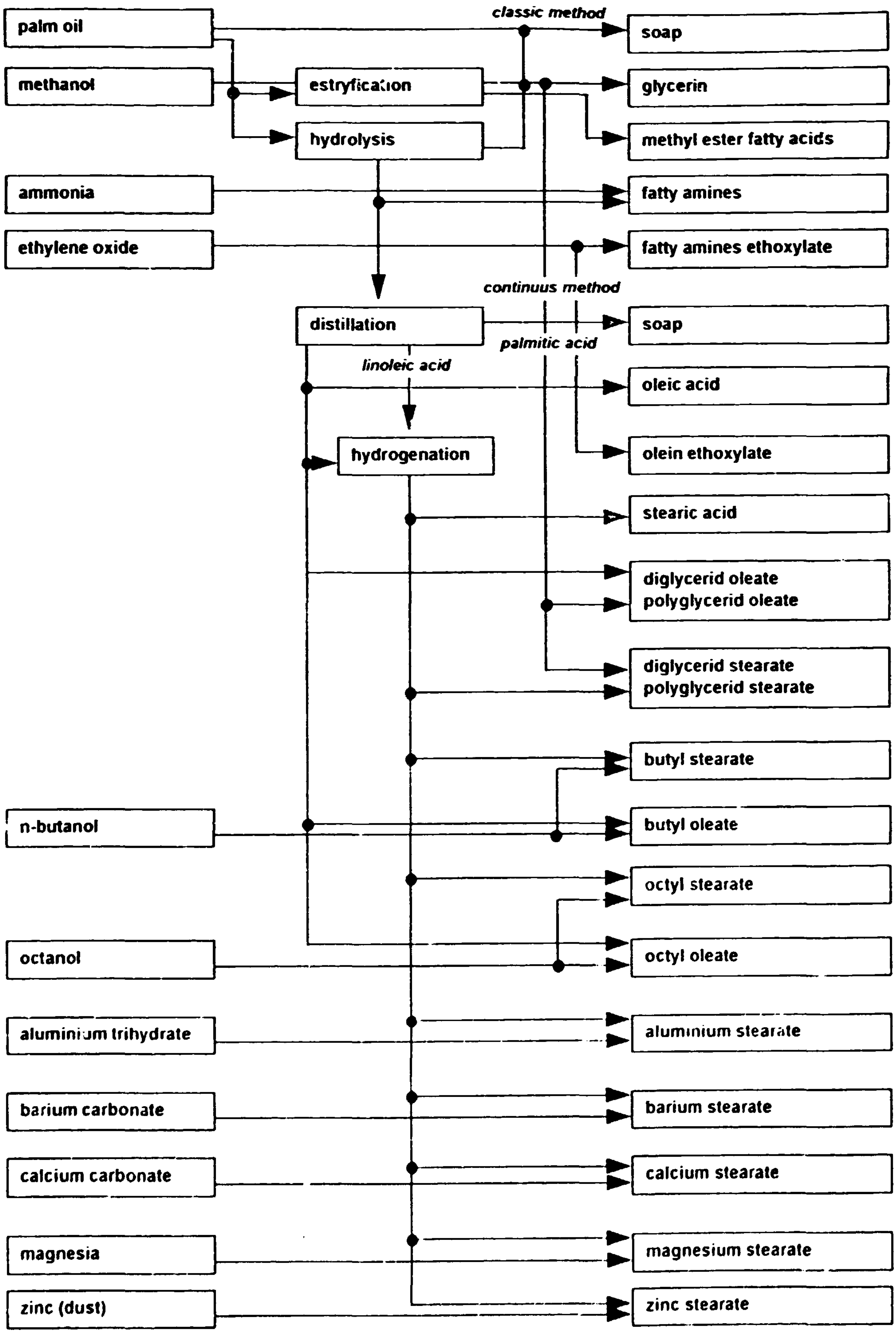
The technological networks are given on flowsheets (Fig.2, Fig.3).



Synthetic Route for Linear Alcohols C_{12} - C_{15} and Surfactants



Natural Route for Linear Alcohols C_{12} - C_{14} and Derivatives



Palm Oil Processing Scheme

B. Development strategies and industrial policies

1. General Methodology

Setting-up the development programme. and in particular the development programme of the petrochemical industry, requires not only collection of a certain amount of data or information, to be processed under a specific methodology, but also implies the need for self-control in the feedback system.

There are numerous examples of development programmes established on the basis of future or expected demand which are not correlated with the macroeconomic options and features of the country economy.

These programmes were either never implemented or their implementation caused an increase of debts or generated other crisis economic features. On the other hand, there are also examples where separate projects were implemented based on a specific project commercial feasibility.

These examples have also shown a low efficiency and some of them are still called "white elephants", due to their deficiency in technology, economy or market assessment or wrong priority selection. This case-by-case approach was transferred from developed countries, where a basic structure of industry already exists and mainly innovations are competing on the market changing the structure of industry and the overall consumption/production pattern of the economy.

However, it would be wrong to expect that there exists a faultless method of development programming.
The decision maker involved in the whole process of the industrialization should not seek the ideal optimum solutions (which does not exist), but establish a reliable system for a feedback information and correction mechanism of the programme implementation. Every programme is suboptimal.

This is due to the multicriterial goal setting which is expected from anybody trying to establish a comprehensive and feasible industrialization programme. Political, economic, logistic and technological constraints are imposing such a pressure on any of the development programmes, that only a proven, realistic and easy to test development thesis can be implementable.

This closed circuit of the programming process should therefore follow the procedure which could be institutionalized as the "set-up and check" methodology. However, always when establishing such a methodology, one should remember what is the objective parameter/variable of the system and which one is the subjective and dependent on the politician's, decision maker's position and opinion. Therefore, before starting the analysis of the procedure, let us investigate what are the features of the potentially implementable methodology. A well proven methodology of the programming process establishes the following elements which are necessary to make any decision in the industrialization process:

1) Selection of the strategies
2) Selection of the industrial structure
3) Selection of the policies

2. Selection of the strategies

Strategies, if identified as the pattern functions for the goal achievement, are partially subjective and partially objective elements of the programming methodology. Their objective character is related to the country macroeconomic patterns, and their subjective character is related to the choices of goals to be achieved. The strategies enumeration is obvious and they have been presented many times in specialized literature.
However, let us enumerate them once more (not necessarily in the order of importance) for a better understanding of their relation to the further steps of the programming process:

- import substitution strategy;
- export promotion strategy;
- resource utilization strategy;
- technological options strategy - labour intensive, capital intensive or advanced (high) versus standard (proven) technology;
- energy intensive or energy saving strategy;
- market slice selection strategy (basic industries versus consumer industries)
- property strategy (private or public sector support);
- strategy of the scale;
- development financing strategies.

However, over the qualitative strategy set selection, the quantitative enumeration of goals is necessary. In Table 24 are given examples of alternative strategies variables.

Table 24 Development strategy quantitative assessment

STRATEGIES	GOAL FUNCTIONS VARIABLES: MVA/capita US $ a/	MVA r% b/	Export/Import ratio (Chapter 5)
EO/SS/FS c\	300	13 - 14	1.3 - 1.8
EO/FCF/FS	150	10 -12	1.2 - 1.5
EO/FJV/LS	60	7 - 8	1.0 - 1.25
EI/SS/FS	200	11 -12	0.9 - 1.1
EI/FCF/FS	70	6 - 7	0.8 - 1.0
EI/FJV/LS	10	4 - 6	0.6 - 0.8
IO/SS/FCS	40	7 - 8	0.3 - 0.4
IO/FCF/FCS	10	5 - 6	0.2 - 0.3
IO/FJV/LCS	3	< 4	0.1 - 0.2

a/ MVA of the chapters 351+352 in US $ in constant 1985 prices b/ MVA r % is a ratio of the MVA of the ISIC 351+352 to MVA total manufacturing;
c/ for decoding see page -ii-

Obviously, in the case of every particular country the establishment of the quantitative variables ranges must be adjusted to particular economic feature.

Strategies obviously can be selected in packages to respond to complexity of the situation. However, when more elements are included into strategy package, then the less oriented movement on the scale of industrialization is observed.

Establishment of the petrochemical complex usually is a mixture of several strategies, namely import substitution combined with export promotion, capital intensive addressed to the consumer and small scale industry markets (e.g. plastics processing) and oriented to involve both; private and public capital with selective participation of foreign petrochemical companies.

Implementation of the strategies requires selection and application of the set of industrial policies. But how can policies be established if the content of the development programme is unknown?

Simple repetition of the existing packages of policies established in the industrialized countries could not work, owing to many reasons e.g., lack of capital market, lack of savings to be capitalized, non-convertibility of the national currency. Therefore, obviously policies should be specific for the promotion of the optimum, specific industrial structure and would not serve for the development of any other type of structure.

3. Search for industrial structure

The second step in the programming methodology is therefore the establishment of the optional (multialternative) industrial structure (technological processing network of raw materials into final consumer goods). This step of programming is an objective element of the methodology.

It is based on an existing set of technological processes, well parameterized on both the production cost and investment cost side. Their analytical assessment may give insight into the options and may also influence the selected strategy.

Here we have the first checkpoint of the programming process. If any of the options analyzed for the future industrial structure does not meet objective efficiency parameters; like Manufacturing Value Added (MVA), profits and their ratios to investment, salaries, capital formation, etc.; it means that the selected strategy should be revised and changed to a different one or to a mixture of other potentially possible ones for a given country.

However, the comprehensive strategy with the selected option for the industrial structure depends very much on applied policies for their implementation.

4. Industrial policies

This third methodological element requires another consideration. Industrial policies are the indisputable part of the instrument with which Government controls the trends of industrial development, because many economic processes have exponential character and moreover they also show lack of continuity. In general industrial policies serve to adjust economic process more or less to the linearity.

What are the potential policies to support industrial development? Once more, options are limited and also well described in specialized literature. However, again for the sake of logic of presentation let us enumerate the policies which are in the hands of the decision makers. There are two categories of the industrial policy instruments:

(a) of a general macroeconomic character:
- taxation policy;
- rate of interest policy;
- customs duties policy;
- depreciation and dividends policy;
- rate of exchange (e.g. inflationary investment policy);
- individual versus social income policy, etc.

(b) of selective, microeconomic character
- special policies (subsidies and special support funds)
  -- raw materials price subsidies;
  -- rate of interest subsidies.

Of course each of the policies has several options (at least two: to be or not to be applied) and a selection of policy means the need for the establishment of the necessary parameter expressed in a specific value. If the policies constitute an objective element of the programming process, the establishment of their parameters is a subjective exercise, as long as the econometric models, allowing even simple simulation, are not available. In our case, the policies and their parameters can be checked in the technological structures, preselected from the previous step.

Therefore, it is recommended when considering the policy packages before establishment of the petrochemical complex, to simulate on the computerized model possible impacts of selected packages on the programme itself and also on the country budget and trade balance.

Below are given basic limits of the industrial policies to be applied when considering establishment of the industrial complex.

Table 25 Policy measures packages (trends and limits)
Leading assessment application function:
- product generation expressed by the ratio of MVA/price

Policy parameters values limits	Raw materials ⟶	Final consumer goods
Custom duties	**0 %**	**35%**
Capital tax	**0 %**	**15%**
Income tax	**uniform**	
MVA tax	**0 %**	**24%**
Export credit facilities (in terms of prevailing rate of interest ratio)	**0 %**	**50%**
Interest rate subsidies (in terms of prevailing rate of interest ratio)	**50 %**	**0%**
Depreciation time	**10-15 years**	**2-3 years**
Raw materials price subsidies	**20 %**	**0%**

Introduced to the models, the necessary concordance between the strategies, industrial structure and policies could be established.

Examples show that few repetitions of the methodological steps may give full concordance between the development objectives, strategies, policies and industrial structure.

5. Procedural steps

This short presentation is very relevant to the macroeconomic planning features presented in the UNIDO methodology, published in the "Guidelines for Industrial Planning in Developing Countries", and shows that a need for the identification of an industrial structure optional model is a central element of the comprehensive programme, which can be presented as a package to national and foreign investors.

Such models were developed by several scientific institutes, and consulting/engineering companies. Particular one specialized package, Multicriterial Industrial Development Aid (MIDA) was used in UNIDO projects on the identification of the business opportunities in several developing countries.

However, every methodology looking for establishment of the production structure of the future industry needs to identify some patterns of the actual and projected consumption, well correlated with the country's or region's specific situation. This means that an estimate of the potential market for the final consumer goods is necessary.

Ways and means to compile this data are crucial for any programming exercise in the chemical industry. Bearing in mind the above mentioned the following summary is given.

Establishment of the goals based on strategies and respective supporting policies requires application of the "feedback" methodology. Therefore, the whole investment promotion system (independent of the economic pattern of the country) should be based on the trial/check step-by-step procedures. The reason for such an approach is that it is impossible simultaneously to establish the strategies (which are independent variables of the development equation) and to check the policies, without having the evaluation of the set of priority projects and their impact on the strategy implementation results. Therefore, the following basic steps are necessary to ensure identification of appropriate business opportunities and promote the foreign investment:

i) Identification of the strategic goals and their definition in the measurable parameters (macroeconomic parametrization);
ii) A sectoral/subsectoral consumption projection based on macroeconomic individual patterns of consumption or on the Leontieff matrix in order to identify markets;
iii) Establishment of the technological network ensuring consumption needs of the final consumer commodities and goods, analytical evaluation of the network, optimization of the industrial structure giving certain scenarios of the constraints and finally selection of the priority investment projects.
iv) Simulation of the resulting structure efficiency under different packages of policies and risk analysis testing the impact of external variables such as prices and demand changes.

The results, which may be presented in the form of the master plan, should be checked again through the intersectoral flows and reviewed in terms of the macroproportions elaborated by the strategies. Of course, due to changeable external parameters (prices and other countries' decisions influencing the market situation, etc.), it is impossible to achieve full integrity and stability of such a programme.

But this is not the aim of exercise. It is sufficient to concentrate the attention of the planner on two or three basic industrial subsectors to elaborate the package of policies supporting the main development strategy. A well integrated policies package will also serve as a motivation in other subsectors in following the given development pattern.

C. Optimization model

Methodology of the search for optimum set of business opportunities is given in Annex I and in project proposal. The standard model is composed of balance equations, constraints and goal(s) functions.

The following optional programmes have been examined:

(1) Implementation of the full production programme (the balance equations are showing the maximum demand) at the maximization of the profit using natural oils as a raw material. In this case from production programme all inefficient investments would be excluded (Case MAXNAT).
Similar case but using synthetic materials (synthetic alcohols and synthetic glycerine) has been investigated to analyze difference between two routes (Case MAXSYNTH).

(2) Implementation of the limited production programme defined by the investment financial resources.
The selection of investment limits is arbitral, however it presents the most efficient production programme. The investment limit has been established at value of 30% of maximum programme (Case INVMIN). Alternative programme satisfying the local demand at limited investment has been also investigated (Case LOCSUP). The latter would correspond the import substitution strategy.

(3) The multiobjective goal function has been also investigated. In this case ratio profit over investment has been maximized as a goal function. To eliminate trivial case of "0" the expected investment expenditures in amount of US $ 1600 million has been introduced and maximum ratio has been searched on production function (Case RATIO).

The values of cost calculation policy parameters are given in the Annex IV and price list of raw materials and products (local and export values) are given in Annex IV. The list of technology sources is given in Annex V.

D. <u>Simulation experiments</u>

1. General remarks

The results are presented in the form of tables for each experiment. Also experiments are compared between themselves: MAXNAT, INVMIN, LOCSUP. The following should be taken into account when analysing results:

- Fixed capital investment is a sum of total expenditures (battery limits and off-sites) as given in technological profiles. Owing the fact that installations are of economic size, the scale up and down factors have not been used. Investment costs are given in 1990 prices.
- PDA stands for Production/Distribution Area and represents the whole technological network. The sales of PDA (domestic and export) are accounting only final products. If any of products is used further in processing line then its value is not added to the sales value. The sales value of all products independently of their further processing life is given under title Gross Production Value. The PDA sales value therefore shows the results if whole PDA would be one enterprise, and GPV shows the sales value if all installations would be separate enterprises.
- Simple rate of return is calculated by division of PDA net income (PDA yearly profit before taxes) by the investment cost of the programme without discounting factor.

- Manufacturing Value Added is calculated accordingly to the well known economic rules.

- Energy inputs and outputs were not calculated and show "0", what does not mean that energy is not consumed. Energy data introduced to the technological profile are considered in the cost calculation.

- Direct labour is considered at the employment efficiency level in industrialized countries. The Supervision and Lab&Control should not be considered as they are dependent on organization and structure of industry.

- Export table shows the amount of products exported accordingly to the market report.

- Import table shows the amount of additional materials needed for production process only. Owing the fact that all installation included into PDA show positive feasibility the alternative import of final products has not been considered. The value of imports is given in Global Results chapter.

- Domestic purchases table shows the additional materials needed for production already produced in Indonesia. The value of domestic purchases is given in Global Results chapter.

- Processes table shows the total capacities of installations to be constructed accordingly to the demand vector. For the sake of investment decision making each capacity should be divided into economic size units e.g. number of linear alcohols installations to satisfy the demand in MAXNAT case would be between 5-8, depending on the growth rate of the demand.

The results of simulation experiments and their comparison are given in Annex VI Part A.

2. Evaluation of simulation experiments

It could be observed that at the prevailing prices of raw materials the synthetic route to the C12-C15 alcohols is less efficient that treatment of natural products (Cases MAXNAT and MAXSYNTH). The difference is substantial and MAXSYNTH PDA yearly profit is lower by US $ 168 million per year and investment cost is higher by US $ 45 million. Therefore, necessary steps should be taken to promote production and sales of coconut and palm kernel oils in Indonesia, increasing proportion between production of CNO/PKO and industrial use. This can be achieved by development of village level agroindustry and relevant pricing policy diminishing the difference between market price of CNO/PKO and price paid to the farmer.

The MAXNAT option requires over US $ 3 billion of investment expenditures, however, the whole PDA is profitable and has highly proexport feature (over US $ 2.3 billion of value).

The amount of raw materials used to satisfy the forecasted demand of local consumption and export is lower then the programmed by Ministry of Agriculture availability for industrial uses. The maximum use of palm oil and Coconut/palm kernel oils by the year 2004 would be respectively about 1.5 million ton and 0.88 million ton.

The basic condition for whole programme implementation is establishment of the ethylene oxide capacity. The production of etoxylated products outside the country is not profitable for Indonesia.

However, in case if regional and international market are not ready to accept the amount of oleochemicals and surfactants estimated in MAXNAT option, two following options have been investigated:

- **Minimum investment (INVMIN case) programme of value of US $ 1 billion.**

  In this case only the most profitable products should be produced and exported. Obviously neither local demand nor the export would be satisfied.

  The efficiency of this small investment programme is much higher and should receive attention of very demanding foreign investors/banks, however imports of final products would reach US $ 580 million. This alternative nearly balances the total exports and imports of products and materials and represents the neutral foreign trade strategy.

  Owing to lower efficiency of the hydrogenation of C12-C14 fatty acids to alcohols, in this alternative industrial use of coconut/palm kernel oil is very small (about 0.13 million ton). Also use of palm oil decreases to 25% of potential supply.

- **Import substitution programme (LOCSUP)**

  considers similar amount of investment (US $ 998 million), but fully satisfies local demand and is also highly profitable. All process capacities are of economic size. However industrial utilization of natural oils is small (palm oil and coconut/palm kernel oils 0.5 million ton and 0.33 million tons respectively, diminishing production and income of farmers substantially.

Obviously, these options do not exhaust many other possibilities, which can be considered by local decision makers and industrial investors. Therefore, it seems that transfer of the know how and software allowing self-reliant and continuous analysis of oleochemicals/surfactants programme would be beneficial to Indonesian industry and would simplify decision making and financing modalities.

For this purpose project document "Selection of business opportunities by simulation procedures" has been prepared and is attached to the report (PART II B).

E. Impact of the industrial policies on the feasibility of the subsector development.

1. Simulation programme

The methodology considered allows also analysis of industrial policies impacts on the resulting investment decisions. Below are given examples of changes in policy measures or investment parameters and their impact on the industrial structure of oleochemicals and surfactants technological network.

The following options were investigated:

- investment programme at given efficiency and limited investment resources contributed as equity. The amount of financial resources has been established at the level of US $ 1.6 billion (nearly half of maximum required for full programme). Assuming profit tax at the level of 50% the 5-years simple return on investment has been considered as satisfactory for investor (Case RATIO).

- the above programme has been recalculated for case of debt:equity ratio equal 70:30 (Case DEBT).

- the above programme has been recalculated for case of decrease of products prices by 15% (Case RISK).

The research results are given in Annex VI Part B.

2. Evaluation of results

The difference between cases RATIO and DEBT is only in profitability as expected. The credit cost at 10% interest would be over US $ 100 million. The production and export structure remains constant. If higher profitability would be requested, then investment programme should be limited to the amount of about US $ 1 billion. The industrial consumption of palm oil and coconut/palm kernel oils remains low (0.83 million ton and 0.27 million ton respectively).

The local demand is not fully satisfied and products of value of US $ 200 million should be imported. However, export value is over US$ 900 million, therefore the case may be considered as highly export oriented.

The RISK case shows that substantial part of local demand should be covered by imports (over US $ 400 million) and export surplus over imports amounts only US $ 200 million. The industrial consumption of palm oil and coconut /palm kernel oils remains similar to the previous cases.

Conclusions and Recommendations

Conclusions

1. Development of the industrial subsector of oleochemicals and surfactants would be highly profitable in Indonesia either in case of import substitution or export promotion strategy. The investment rate of about US $ 300 million per year is necessary to achieve during next ten years adequate stage of development of oleochemicals and surfactants industry allowing consumption of available natural oils.

2. Substantial part of high value added products is based on stearic acid, therefore large scale hydrogenation of oleic/linoleic acids should be considered if substantial amount of tallow is not available. This leads to specific processing line of fatty acids, combining by-products to produce high quality soaps.

3. Oleochemicals and surfactants have found application in formulated mixtures practically in all branches of industry, however necesary development of formulation and recipes of high quality additives limits their utilization. Without R&D capability accessible to the industry, oleochemicals and surfactants local utilization on wide scale is not possible. Also marketing products for export requires availability of advisory specialized services which are not possible to get for small and medium scale industry.

4. Continuous adjustment of the development programme and business opportunities promotion adequate to the range of investment requires implementation of decision support systems, which option has been presented in the report.

Recommendations

1. The proposed export programme should be tested in regional Asia-Pacific market study. In particular China should be considered as potential market.

2. The R&D Centre of oleochemicals and surfactants technology, formulation and application should be established as a joint venture of Government and relevant Industry Association with the assistance of UNIDO. The activities of the Centre can be financed from raw materials levies. The detailed description of the concept and modalities of operation are given in the attached Project Document.

3. Feasibility studies for number of projects should be prepared as future risks owing to the price or demand decrease seems to be very limited. Selection of projects for feasibility studies should be based on well established methodology of the business opportunities selection. Modalities of the know how transfer to the Ministry of Industry staff and Industrial Association have been presented in the attached Project Document.

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Annex I. Methodological guiddelines (MIDA)

I.1 Integrated development programming: MIDA decission support methodology

The aim of the material collected below is to provide with some information which could be used as a kind of compendium of selected knowledge on Integrated Development Programming (IDP). To meet the above objective several related areas were covered — their common thread is IDP exemplified by MIDA — Multiobjective Interactive Decision Aid.

Main section of the chapter covers scope and perspectives of modeling with emphasis on so called MIDA approach. A verbal description of elements of the system is given providing a base for methodology which considers programming development as a quest for concordance between available resources and technologies.

A. Scope and perspective of development programming

Chemical industry and management of change

The world is permanently passing through a chain of great economic, social and technological changes. Recognition of this fact and of the need to control the forces of change has stimulated world-wide interest in the problems of change and methods for coping with them.

Nowhere is the need for management of change more crucial than in the industrial sector, where many factors can affect the growth or decline of individual industries and the resulting industrial structure. The process of change with perhaps the highest impact affects the chemical industry.

Here we concentrate on management of the chemical industry due to the problems it faces as a result of global change, particularly as a result of changing patterns of raw materials and energy use.

The importance of the chemical industry is often greatly underestimated. Not only does it provide soaps, detergents, medicines, but also pesticides, fertilizers, synthetic rubbers, plastics, synthetic fibers... — in fact, our modern technological society could be said to be founded on the chemical industry.

One of the most surprising facts about this industry is that a large proportion of its many products are derived from only a very small number of starting materials, of which hydrocarbons are probably the most important.

As the processing of natural resources with mineral or agricultural origin proceeds, the chains are branching with each processing phase from one generation of intermediates to another. The developed chemical industry presents in fact ever growing network of interlinked technologies. Final or market goods originating from this network provide only a small share of the total chemical production which does not exceed 25% of the final turnover of the industry. The necessity to meet the challenge of the management of change led to a practical action it is to development of a a methodology capable of design of feasible restructuring and/or structuring alternatives in various sectors of the chemical industry.

The approach chosen takes into account a variety of interrelated and alternative production processes (either in use or under development), compares their efficiency, their consumption of different resources etc. and finds a combination of technologies that best meets assessed needs while staying within the limits imposed by the availability of resources and environmental constraints.

Programming development — MIDA approach

From the above essential overview two spheres to be identified emerge. First is the sphere of the present and forecast performance of the industry which is a result of the identification. It should be described formally in order to represent the changes that are to transform the industrial structure in time. Second is the sphere of management of the changes where decisions are to be worked out and a decision support is to be developed and naturally embedded into the decision process.

From the above follows that a basic model of industrial structure (IS) must be provided to map the first sphere. It must be based on important assumptions regarding the decision on the appropriate aggregation level as well as on the boundaries of the industrial structure considered. If the management of change is going to be executed through Integrated Development Programming, then such a sphere of activities can be considered as a process of design of an Industrial Development Strategy (IDS).

IDS design is considered as a decision process based on generation of efficient development alternatives expressed in terms of goals, critical or indispensable resources as well as selected array of technologies which are to be utilized. The alternatives are to be generated, selected and ranked along assumed efficiency measures.

The aim of the development programming or IDS design is a selection of the alternative which is to change the industrial structure by means of investment over the time. Due to the dynamic properties of the development process, and specifically the development cycle of technology ([3]), the time span under consideration is of the range of 10 - 15 years. The straightforward conclusion is that due to the dynamic nature of the development process, IDS design is to be treated and solved as a dynamic problem. It has to be strongly underlined, however, that any attempt to formulate a general multidimensional dynamic problem as a means for generating feasible development alternatives must lead to oversimplification and severe loss of important factors which should not be overlooked. At the same time, any decomposition must assure that through a coherent methodology all the subproblems can be solved as integral parts of the same system. A fundamental premise for the phenomena of development is the fact that as time perspectives become longer (5,10,15... years), the reliability and accuracy of data describing the future decreases.

To meet the challenge of a real application in a complex decision environment, a method better responding to a managerial practice was elaborated. It is based on a decomposition of this in fact dynamic problem along space and time. Before going into discussion of the kind of properties of a decision problem (or problems) that are to be formulated and solved, let us make a step further in the identification of IDS design.

To perform IDS design with focus on generation of development alternatives and their selection, **following elements are to be considered**:

- **Existing industrial structure** in terms of consumption coefficients capacities and relevant economic data,

- **Potentially available technologies** for construction of new plants,

The above two categories form a technological repertoire out of which a new industrial structure is to be devised providing that a harmony between existing elements and the new ones must be sustained. The next category of elements for analysis are:

- resources which are to be utilized in order to implement a new structure, such as investment, manpower, water, energy etc as well as resources which are to be supplied as feedstock to run the new structure.

- **some of the resources considered are** selected in a special way and **called critical resources due to the fact that their availability is a necessary condition to** make development alternative feasible.

Critical are those resources which are nominated as such by the decision maker for either being particularly scarce or difficult to obtain; examples may be crude oil, manpower, energy or capital. In practice **the set of critical resources is closely related to the set of criteria, since the aim is to find an optimal solution with respect to all critical resources.** Technological constraints are quite easily identified and are related to factors such as production capacities and operating conditions. All other elements in the analysis, such as demand for a particular product, the availability of (noncritical) raw materials, fall into the category of complementary or auxiliary information which describes environment to the industrial activities such as terms of trade — specifically prices. On the contrary, a demand for selected significant products as well as availability of selected significant feedstock falls into the category of critical resources.

It is clear that whether a resource is selected as critical or not, it depends on the formulation of the decision problem. In fact, a resource can be nominated to one category or to the other by the decision maker and that in a simple way assures flexibility of predecision analysis since each reassignment to or from the list of critical resources corresponds to a simple redefinition of the decision problem.

With the above background we **can now define the task of IDS design or generating efficient development alternatives as a quest for concordance between available resources and technologies.**

The state of concordance is to be evaluated along well defined rules and measures for evaluation (and selection) of the efficiency of achieving goals (outputs) from resources supplied to industrial structure (inputs). Such rules and measures form a model of efficiency evaluation which is to be established in order to solve the quest for concordance to yield a feasible development alternatives. This problem area is dealt with in IV chapter).

Technological repertoire, critical resources, constraints and other factors describing the problem (or a particular industrial situation), are to be mapped into second model of a technological network.

Since it is intuitively obvious that such a process is to be performed through the generation and analysis of multitude of alternatives and their selection, then a mechanism is to be provided that enables to handle the situation. The appropriate models and means for handling the problem of quest for concordance may be organized into a system which is called simply DSS or Decision Support System.

The above philosophy stands behind development of MIDA system and the methodology. In the next step we shall present the assumptions used and a decomposition of the development problem which were applied for practical implementation of the above philosophy.

The effective approach taken in MIDA methodology in the practical implementation of the idea of the quest for concordance can be presented as follows. With respect to the decision level of the programming development, MIDA locates the IDS design on a level which could be named an intermediate economy level. It goes between a macroeconomic level and microeconomic or corporate level. The first one proves to be too aggregated; a single technology cannot be considered in the analysis. Therefore a selection and assessment of appropriate technologies cannot be done at the macroeconomic level. On the other hand, a corporate or enterprise level also proves to be inadequate. This level is too narrow and particular to comprise complex technological and economic relationships which interact in the development process in the industry.

By identifying, defining and choosing the intermediate level, as the operational one for development programming, an important original feature has been decided in MIDA development. It comes together with the choice of an entity for setting the feasible scope of an industrial development problem which may be regarded as a basic object of the decision analysis. It is called PDA or Production Distribution Area. It responds to the necessity of a formal model of an industrial structure (IS) of the chemical industry (this model is formally described in next chapter).

Due to a possibility of simple aggregation and disaggregation of the elements described in terms of the PDA model, also the PDA level can be split into several levels along so-called problem hierarchy. This assures flexibility of the analysis and well corresponds to the industrial practice allowing at the same time to apply MIDA on different levels of aggregation (with data appropriate to the level considered). It makes the concept and application of the PDA model very flexible and rather universal.

From the process of quest as considered so far on the PDA level, a goal structure can be selected representing the assumed state of IS at the end of the horizon covered by the analysis. However, to complete the task of programming, development of a feasible way of transition from the present or actual IS to the selected, final IS is to be optimally selected. The transition is to take into account the following factors:

- technological and market priorities,
- location possibilities,
- construction potential capabilities,
- availability of investment.

In short, to consider these factors, the investment necessary for the transition must be allocated both in space and time.
Therefore three levels emerge and provide a mentioned above decomposition (see Kopytowski and Zebrowski, 1989) which was assumed in MIDA:

- selection of the final or goal IS,
- space allocation of investment,
- time allocation of investment (or investment scheduling).

Appropriate feedbacks between these levels provide through the space and time allocation a feasibility analysis of the goal structure originally selected.

The three level hierarchy and specifically, the space allocation and investment scheduling levels are discussed both theoretically and practically (through example) in (Skocz et al., 1989).

It must be underlined at this point, that in fact the decomposition of the IDS applied in MIDA approach corresponds to the managerial practice. On the other hand, it can be conceptually opposed to more theoretical approaches based on dynamic programming which in general aims at global solution to be obtained from one model.

The general approach applied in MIDA follows from the common decision practice. First the goal "what" must be selected, then questions "where and how" should be answered. The decisive factor here is that the spatial allocation demands more detailed information related to sites and this must be confronted with spatially disaggregated values of critical resources as obtained from global solution. Site specific constraints must be also obeyed.

One more methodological disadvantage comes from globally formulated and solved problems — difficulty of interpretation — especially of cause-effect type. Too many factors are involved at once to enable that kind of analysis. It makes a real interaction with decision maker rather illusory.

B. Experience from applications

Major MIDA applications

For the scope assumed in this presentation of MIDA system and methodology some most important and representative applications were selected. The list of applications to be discussed is as follows:

1. **Polish Government Energy Program** — MIDA was used to elaborate a strategy for integration of energy and chemical sectors. MIDA study contributed to the fact that a new development, namely energochemical processing of coal, was brought to light and attained its place in the long-term policy.

2. **UNIDO projects**. JSRD competed successfully in offering its services to UNIDO and performed the following projects:

   - Master Plan for Development of the Chemical Industry in Iran,
   - Master Plan for Development of the Chemical Industry in Algeria,
   - Master Plan for Development of the Petrochemical Industry in Algeria.

   Within the framework of the above projects the services covered:

   - delivery and installation of equipment and adjacent software as well as delivery and installation of MIDA Decision Support System,
   - training of the counterpart personnel (using lectures, video tapes, top executive seminars and most of all *learning by doing* methodology),
   - elaboration of the development program in various alternatives,
   - industrial and system analysis consulting.

3. **Shanxi Case Study** — this application was done as a part of ACA project in IIASA for Shanxi Province in People's Republic of China and services performed were similar to those described for UNIDO, but the DSS software was developed as a spatially oriented version of the models incorporated in MIDA. The development program for coal based chemical industry was elaborated for the Shanxi province and technical expertise was also shared with the counterpart.

4. **SADCC Study** — *Study of the manufacture of industrial chemicals in the member states of SADCC* — this application was done under the contract with a consulting firm. The firm was contracted for a UNIDO project for SADCC countries. SADCC stands for Southern African Development Coordination Conference. Its members are 9 countries: Angola, Botswana, Lesotho, Malawi, Mozambique, Swaziland, Tanzania, Zambia, Zimbabwe. The consulting company contracted JSRD to perform application of MIDA system for the above study.

5. **Workshop on Integrated Development of the Chemical Industry**, organized by UNIDO for Brazil. This kind of workshop on IDP is based on the series of lectures and PDA case studies performed by participants using MIDA system. Learning by doing methodology is applied.

The above applications can be categorized to show range of problems and areas that can be tackled with a DSS and methodology such as MIDA as well as to provide a useful generalization of experience gained.

First category

A problem area related to the development of industrial sectors such as chemical and energy industries is selected. A research is to be carried out and forecasts provided with various technological and development alternatives. This is kind of predecision analysis which includes both research and application type of activities. The responsibility of JSRD as a contracted party covers all the work and study that may be considered as a kind of long range research programs with step by step results to be produced in form of progress and final reports. Results are used by various governmental agencies as well as other scientific centers.

This kind of application is exemplified by no 1 on the above list.

Here a DSS is used by the team performing the job mainly as a laboratory tool. No clearly defined decision maker is present in the process. In such case a variety of skills and experience, specifically presence of industrial experts in the team is especially decisive for good results to be obtained. In such cases by in parallel promoting a work devoted to the problem and a work done on developing methodology and DSS system proves to be fruitful and effective. Such in fact is organization of work assumed by JSRD.

Second category

A development program is to be elaborated for a foreign partner. Such were the applications that were contracted by JSRD with UNIDO. This covers wide span of services and responsibilities. The period assigned for the job is relatively very short : in the range of 1,5 — 3 month.

The DSS is to be delivered and installed together with computer equipment. Moreover, a user's team must be trained in a variety of skills including not only operation of DSS but first of all methodology of its application. These circumstances impose variety of demands which for the lack of space and the type of paper cannot be discussed in details but must be of deep concern. They can be briefly presented as follows.

The principle of operation of a DSS and methods applied should be as clear as possible and as simple as possible at the same time they must eliminate omitting or loss of any essential factors.

A great attention in DSS architecture, functioning and methodology must be paid to facilitate procedures which may help in validating both : simple source data and resulting development alternatives.

Users' involvement is a key factor, both to assure obtaining valuable and useful alternatives that would be accepted for implementation and to establish self-reliance of the users' team (including a decision maker). This can be done through very extensive educational effort and specifically by working out a "learning by doing" methodology. This must be backed also by very clear and well edited documentation supporting all activities as well as results of the project.

If one would like to compare the two above categories of application it could be formulated as follows.

First category provides more scientific and broad approach but is much less demanding in terms of software development, methodology and reliability of the system. On the other hand the second category provides extremely heavy duty testing of all elements taking part in the project.

This includes also all skills and abilities of people involved. It also provides important insights coming from different cultural and decision environments.

Moreover it provides also very useful cases which are an inspiration for the future developments in all aspects : theoretical, software and methodological.

Third category.

The system and methodology are to be adopted for different environment and are to be embedded in another system. Such is the case of the Shanxi case study a work done for ACA IIASA project contracted with Peoples Republic of China.

Apart from the previous remarks formulated for the case of UNIDO projects which remain valid, some additional observations can be formulated.

A DSS becomes a module of a larger system. All kinds of problems of interfacing with other types of software arise. The same concerns interfaces with other models.

At the same time in this particular case new elements specific for spatial allocation backed by scheduling of investment were also developed. In general this kind of applications help finding another way to generalization and standardization of architecture and functionality of the DSS not to mention new theoretical and methodological developments which usually also come in dealing with new, original problems.

Fourth category

This is a specific one when there is no direct contact with the field. The interface comes through third party. It provides a very useful kind of verification of system and methodology. It was the case of the fourth application listed above.

The experience gained so far from a single case reported here may be too limited to be generalized but due to difference in approaches and experience represented by the third party which is supposed to be professional in the field of programming development, a new light can be brought on the own approach which has to defend itself in such circumstances. In fact it also helps to test and improve system and methodology with procedures for validation of data and results.

Fifth category

Though exemplified here explicitly by one project in fact it is an important area of many applications in a number of countries including India. Moreover in each project a component of "learning by doing" was always present. The teaching environment proved to be a very challenging one and helped to improve methodology, especially in terms of conveying knowledge on rather specific, professional topics to participants representing a multidisciplinary group, with diversive experience and background.

The above remarks summarize briefly experience in the domain of DSS as gained from major, categorized for that purpose applications of MIDA. Generality of categorization as well as of the relevant experience prove to be useful not only for a specific DSS such as MIDA.

MIDA or Multiobjective Interactive Decision Aid was used here to highlight various aspects and problems of decision support. Being on one hand a particular DSS aimed at application in a particular management area namely IDP — Integrated Development Programming, on the other hand proves to be a good platform for general observations that can be shared well beyond immediate field of its origin and application. This involves the problem of identification. It led to a counter-intuitive from the general theory point of view decomposition of the complex dynamic problem. Consequently it also led to the development of the MIDA system which evolved in time with its core being PDA or Production Distribution Area model. In the system the data availability (to provide the user with detailed descriptive information) is of equal importantce with modeling capability (to provide him with normative information). It is assumed therefore that both categories of information are important in the process of learning and experimenting on the way to selection of a decision alternative. A great variety of options which can be accessed through the hierarchical menu of MIDA enables for a good interaction between user and problem performed in terms which come from normal practice of experts and decision makers. This is a feature which should be common in any DSS application. Lessons from various categories of applications show that DSS should be considered both as a laboratory tool for development of theory and methodology of decision support but also as a crude means in dealing with real decision problems. It simply shows that design, implementation and application is an open-ended process in which feedbacks from experience assure that this learning by doing process is both creative and rewarding in its scientific and practical effects.

I.2 General information on MIDA-90 computer system

MIDA-90 — *Multiobjective Interactive Decision Aid* computer system is treated here as a tool devised to support the user with computer programs to apply development programming methodology called MIDA methodology persented in previous chapters.

Before a detailed description of all functions of the system will be given, its basic modules are briefly presented in order to make the user familiar with the system's structure and to help him to associate the particular options with the system's architecture.

In brief, the MIDA-90 computer system has been designed as a *menu-driven, screen oriented* and *user-friendly* Decision Support System (DSS). It means that everybody who operates the system is guided with a hierarchically organized collection of menus that contain all functional options offered by the system. Therefore no direct calls to the computer operating system are required and the software incorporated in the system is transparent to the user.

Data Base Module

The **Database Module** consists of a database, which is an organized collection of information and a database management system (DBMS) that enables the user to enter, store, manipulate and retrieve information organized into the database. The DBMS provides interactive access to the database and provides easy ways to create printed reports.

The Database Module is designed according to the MIDA-90 methodology and as such is incorporated into the Decision Support System Therefore its facilities take into account unique requirements and structure of such a system. Most important, from the user's point of view, are the facilities related to data entry and retrieval. While performing the two above functions, the user is guided by a collection of custom-designed forms. The forms are used as an input vehicle to feed into the system database the parameters of technological processes as well as technological and economic data on installations. Modes of manipulation within the database are supported by DBMS.

For example, if the user needs information concerning a particular process (e.g. phenol production) he may call a process oriented form and select the query option for searching the process of the given attribute (i.e. production of phenol). The same may refer to other data stored in other tables (files) of the database such as INSTALLATIONS, CHEMICAL OR MEDIUM etc Apart from the QUERY option for data retrieval, the user may choose other modes of operation as e.g. ADD, UPDATE, DELETE.

Hence, the DBMS allows the user to browse through rows (records) and tables to find information based on search values. Once a row is displayed, he can delete or modify it and also add the new rows. Moreover, the DBMS provides sophisticated methods of data checking and protection.

The database content may be reported upon request in a format that best suits the user's needs. The database report writing module is very flexible and allows to combine information from more than one table into a report.

Since the Database Module is a part of the overall DSS, it is provided with extensive possibilities of communication with other modules. To assure the communication, control procedures (written in C) are incorporated into the module. It is done owing to database library routines that allow C programmers to manipulate the data in the database with specialized custom-built programs.

PDA — Model Generation Module

The basic function of the PDA (Production Distribution Area) Model Generation Module is selection and transformation of data stored in the database by creating a MPS file, a DICtionary file and a CHANGE file. The MPS file contains information organized according to linear programming standard of IBM called MPS (Mathematical Programming System 360 Version 2) which is widely used for such applications. It is important that the structure of the MPS file reflects an assumed structure of the model selected for the simulation experiments.

The DICtionary file contains description of chosen MPS codes (names) in natural language as well as specification of reports for every optimization run. In principle this file is a cross-reference array that combines MPS codes and real-life names as well as parameters of scale and units introduced for variables that occur in the solution. The latter information determines also an order and classification (attribute-oriented cross-cutting groupings) of the reported results according to requirements of the user.

The CHANGE file indicates the media that can be modified during simulation experiments on a given model. It also defines a set of criteria that can be selected for the optimization run, the kinds of constraints or single parameters of the PDA.

PDA — Optimization Module

Implementation of the Optimization Module is crucial for effectiveness of the whole system. Since the considered PDA-like models are large-scale LP problems (number of variables can be of the range 500-5000 and more), there are high requirements on effectiveness and numerical stability of the applied software. It means that implementation of a module based on a professional LP package is beyond discussion.

The next important assumption to be held in the implementation project is that all modifications of the LP problem are to be performed directly in the computer core (i.e. in the arrays of LP package). Therefore it must be possible to call optimization package as a subroutine. It may be sometimes difficult to satisfy the latter requirement due to the specific structure of many packages or to lack of appropriate documentation.

An example of highly professional software that can be easily adopted for the module is MINOS package (Stanford Univ., 1977). For the PDA-like models this package has been extended with multiobjective and fractional-objective procedures and sensitivity analysis routines. A new issue of the package developed by JSRD, called OPTIMIST, has been extensively tested and then incorporated into the module.

As other modules of the DSS, the Optimization Module is a menu-driven one and it communicates with other parts of the system.

Report Writing Module

The Report Writing Module's function is two-fold. First, it controls the output of the optimization run following the structure of the DICTIONARY file created by the Model Generation Module. Second, it enables to produce reports in any form required by the user.

As to the first function of the module, it is an interface between the Optimization Module and Data Base Module. In that sense it transforms the optimization results in order to load them into the database.

The second feature of the module is supported by the relational report writer of the database management system. It means that the report writer allows to gather different elements from the database. Once the information is put together, simple but powerful report-formatting statements allow to construct reports containing any subset of the database. Since results of a number of simulation experiments can be stored in the database, the module may be used to compare selected experiments from various points of view.

Beyond such straightforward application of the module, it offers more advanced functions such as calculations on selected items, output control due to logical conditions on the output data, sorting etc.

Auxiliary Module

The Auxiliary Module provides the user with tools for maintenance of the archive, for making backups, and re-installation of MIDA-90. The module provides the user with functions that facilitate protection of the database and the system's software against damages that are very likely in the situation of e.g. frequent power cuts.

Investment Scheduling Module

The Investment Scheduling Module enables optimal (or sub-optimal) investment scheduling in different branches of the chemical industry according to a chosen criterion. It also enables defining best starting and completion times of chemical complexes' construction.

The module is not integrated with the MIDA-90 system what results in necessity of separate data input. Classic optimization algorithms have been used.

The module is designed, like the MIDA-90 system as a *user-friendly, menu driven* system of the structure and operating principles similar to those of MIDA-90.

Annex II List of technological profiles

process_name	capacity MTPY
OLEOCHEMICALS:	
FATTY ACIDS FROM PALM OIL (HYDROLYSIS)	45000.00
FATTY AMINES FROM PALM OIL FATTY ACIDS	9000.00
OLEIC ACID (PO FATTY ACID DISTILLATION)	30000.00
OLEIC/LINOLEIC ACID (PO FATTY ACID DIST)	30000.00
STEARIC ACIDS BY HYDRGENATION OF FATTY ACIDS	20000.00
ESTERS AND ETHERS:	
BUTYL OLEATE	15000.00
BUTYL STEARATE	15000.00
DI-GLYCEROL OLEATE	20000.00
DI-GLYCEROL STEARATE	20000.00
2-ETHYLHEXYL OLEATE	15000.00
2-ETHYLHEXYL STEARATE	15000.00
LAURYL GLYCOL ETHER	20000.00
METHYL ESTERS FATTY ACIDS	100000.00
MONOMETHYL ETHER	100000.00
POLYGLYCEROL OLEATE	20000.00
POLYGLYCEROL STEARATE	20000.00
STEARIC GLYCOL ESTER	20000.00
METALLIC SOAPS:	
ALLUMINIUM STEARATE	20000.00
BARIUM STEARATE	20000.00
CALCIUM STEARATE	20000.00
MAGNESIUM STEARATE	20000.00
ZINC STEARATE	20000.00
FATTY ALCOHOLS:	
PRIMARY ALCOHOLS, LINEAR C12 - C14 BY CNO/PKO HYDROLYSIS	50000.00
PRIMARY ALCOHOLS, LINEAR C12 - C14 BY CNO/PKO METHYL ESTERS	50000.00
PRIMARY ALCOHOLS, LINEAR C12 - C15 SYNTHETIC	120000.00
SOAPS:	
SOAP FROM PALM OIL (CLASSIC METHOD)	30000.00
SOAP FROM PALMITIC ACID (CONT. METH.)	30000.00
SURFACTANTS:	
AMMONIUM LAURYL SULFATE	20000.00
FATTY AMINES ETHOXYLATE	40000.00
NONYLPHENOL ETHOXYLATE NONIONIC SURFACT.	45000.00

NONYLPHENOL ETHOXYSULFATE SODIUM SALT	20000.00
OLEIN ETHOXYLATE	20000.00
PRIMARY ALCOHOL ETHOXYLATE	40000.00
PRIMARY ALCOHOL ETOXYSULFONATE	20000.00
PRIMARY ALCOHOL SULFONATE	20000.00
SOD. ALKYLBENZYL SULFONATE FROM N-PARAF.	80000.00
TEA LAURYL ETHOXYSULFATE	20000.00
TEA LAURYL SULFATE	20000.00

RAW MATERIALS:

ALLYL CHLORIDE FROM PROPYLENE BY CHLORI.	90000.00
CHLORINE (USING DIAPHRAGM CELLS)	360000.00
EO BY ETHYLENE AIR OXIDATION	135000.00
EO BY ETHYLENE OXYGEN OXIDATION	135000.00
ETHANOLAMINES FROM AMMONIA AND EO	100000.00
GLYCERIN FROM ALLYL CHLORIDE	45000.00
NONENE (PROPYLENE TRIMER)	20000.00
OLEFINS,LINEAR,BY C2H4 OLIGOMERIZATION	70000.00
P-NONYLPHENOL (A BORON TRIFLUORIDE CAT.)	20000.00
P-NONYLPHENOL (AN ION-EXCHANGE CAT.)	20000.00

Annex III. Cost calculation policy parametres

```
+----------------------------------------------------------------------+
|                   M A I N   P A R A M E T E R S                      |
+----------------------------------------------------------------------+

 PDA name                 [SURFACTANTS PDA                    ]

 local                    [1.0    ]   labor wages              [12000.0]
 exchange rate            [1.0    ]   supervision wages        [12000.0]
 blcc depreciation        [10.0   ]   laboratory wages         [12000.0]
 offsites depreciation    [5.0    ]   operation supply cost    [0.75   ]
 debt/equity ratio        [0.0    ]   direct overhead          [60.0   ]
 interest on debt         [10.0   ]   maintenance cost         [5.0    ]
 working capital          [10.0   ]   maintenance wages factor [50.0   ]
 interest on work. cap.   [15.0   ]   administration           [10.0   ]
 insurance                [2.0    ]   sale & marketing         [5.0    ]
 property tax & rent      [1.0    ]   R & D                    [3.0    ]

------------------------------------------------------------------------
```

MAIN PARAMETERS form

This form is displayed after the Main Parameters option of the database submenu of MIDA system is selected. The following items are included into this form:

PDA name

location factor — it is the ratio of Fixed Capital Investment (FCI) for local conditions over the standard (Gulf Coast) case; the default value is 1;

exchange rate — the rate of Local Currency exchange vs USD should be entered;

blcc depreciation — the depreciation rate in % is to be entered; the default value is 10%;

offsites depreciation — the depreciation rate in % is to be entered: the default value is 5%;

debt/equity ratio — the share of external loan in the FCI value in % is to be entered;

interest on debt — the interest rate in % is to be entered;

working capital — the relative value in % of the Total Capital Investment (TCI) is to be entered;

interest on working capital — the interest rate in % is to be entered;

insurance — the relative value in % of the FCI is to be entered; the default value is 0.5%;

property tax & rent — the relative value in % of the Fixed Capital Investment is to be entered;

labor wages — the average yearly wages of labor in local currency;

supervision wages — the average yearly wages of supervisors in local currency;

laboratory wages — the average yearly wages of laboratory staff in local currency;

operation supply cost — this includes costs of maintenance materials expressed as a percentage of FCI; the default value is 0.8%;

direct overhead — the relative value in % of the sum of direct labour, supervision and maintenance costs; the default value is 60%;

maintenance cost — the relative value in % of the Fixed Capital Investment; the default value is 5%;

maintenance wages factor — the relative value in % of the maintenance cost; the default value is 50%;

sales & marketing — the relative value in % of Factory Manufacturing Cost (FMC); the default value is 15%;

R&D — the relative value of research & development cost in % of Factory Manufacturing Cost; the default value is 3%.

Annex IV. Price list of products considered

Code No.	Medium	Market	Price USD	/ unit
1	COOLING WATER	p	.0200	M3
2	PROCESS WATER	p	.2000	M3
3	STEAM	p	12.0000	T
4	ELECTRICITY	p	.0600	KWH
5	INERT GAS	p	.0200	NM3
10	ACETIC ACID	i	730.0000	T
40	ALLYL CHLORIDE	p	1570.0000	T
43	ALUMINA TRIHYDRATE	i	279.0000	T
47	ALUMINUM PELLETS	i	3420.0000	T
56	AMMONIA	p	180.0000	T
82	BENZENE	p	344.0000	T
90	BORON TRIFLUORIDE	i	8360.0000	T
107	N-BUTANOL	i	840.0000	T
143	CALCIUM CARBONATE	i	51.0000	T
144	CALCIUM CHLORIDE	p	125.0000	T
152	CARBON DIOXIDE	s	.0000	T
161	CATALYST AND CHEMICALS	i	1.0000	USD
178	CAUSTIC SODA	s	250.0000	T
183	CHEMICALS	i	1.0000	USD
186	CHLORINE	p	200.0000	T
210	COCONUT/PALM KERNEL OIL	p	490.0000	T
247	FATTY AMINES ETHOXYLATE	s	2200.0000	T
		e	1980.0000	T
248	LAURYL ALCOHOL ETHOXYSULFONATE Na	s	1800.0000	T
		e	1640.0000	T
262	DICHLOROPROPYLENES	s	858.0001	T
265	DIETHANOLAMINE	s	1250.0000	T
331	ETHYLENE OXIDE	p	995.0000	T
341	ETHYLENE	p	420.0000	T
342	2-ETHYLHEXANOL	i	950.0000	T
379	GLYCERIN	s	1300.0000	T
		e	1100.0000	T
388	HEPTANE	i	380.0000	T
401	HYDROCHLORIC ACID (DILUTE)	s	168.0000	T
403	HYDROCHLORIC ACID	p	214.0000	T
406	HYDROGEN (97 VOL %)	p	.1330	M3
427	ION-EXCHANGE RESIN (CATION)	i	5780.0000	T
458	LIME	p	43.0000	T
460	LINEAR OLEFINS	s	1200.0000	T
464	MAGNESIUM OXIDE	i	1650.0000	T
482	METHANE	p	.0600	NM3
485	METHANOL	p	100.0000	T
519	MOLECULAR SIEVES	i	4410.0000	T
523	MONOETHANOLAMINE	s	1430.0000	T
555	NONENE (PROPYLENE TRIMER)	p	605.0000	T
557	NONYLPHENOL ETHOXYLATE	s	1400.0000	T
558	NONYLPHENOL	s	1100.0000	T
585	N-PARAFFINS C10-C13	p	550.0000	T

607	PHENOL	i	750.0000	T
618	PHOSPHORIC ACID (INDUSTRIAL GRADE)	p	735.0000	T
697	POTASSIUM CARBONATE	i	700.0000	T
698	POTASSIUM HYDROXIDE	i	1000.0000	T
703	PRIMARY ALCOHOLS LINEAR, C12 & C14	s	1250.0000	T
		e	1100.0000	T
704	PRIMARY ALCOHOLS LINEAR, C12-C15	s	1250.0000	T
		e	1100.0000	T
714	PROPYLENE	p	350.0000	T
735	SALT	p	25.0000	T
740	SILICA GEL	i	2290.0000	T
747	SOAP	s	820.0000	T
		e	770.0000	T
749	SODIUM ALKYLBENZYL SULFONATE	s	1350.0000	T
		e	1230.0000	T
755	SODIUM CARBONATE	i	150.0000	T
758	SODIUM CHLORIDE	p	25.0000	T
807	SULFUR TRIOXIDE	p	198.0000	T
810	SULFURIC ACID(IN 65%)	s	27.8000	T
811	SULFURIC ACID	s	69.0000	T
812	SULFUR	p	80.0000	T
818	SYNTHESIS GAS (2:1)	p	70.6000	MNM3
824	PALM OIL	p	330.0000	T
825	PALM OIL FATTY ACIDS	s	650.0000	T
826	PALM OIL FATTY ACIDS PRIMARY AMINES	s	2200.0000	T
		e	2000.0000	T
854	TITANIUM DIOXIDE	i	2150.0000	T
862	TOLUENE	p	303.0000	T
872	TRIETHANOLAMINE	s	1320.0000	T
972	OXYGEN (MODERATE USAGE)	p	38.6000	T
1160	BARIUM CARBONATE	i	550.0000	T
1297	LAURYL ALCOHOL SULFONATE SODIUM SALT	s	1450.0000	T
		e	1300.0000	T
1301	LAURYL ALCOHOL ETHOXYLATE	s	1500.0000	T
		e	1370.0000	T
1302	TEA LAURYL SULFATE	s	1900.0000	T
		e	1700.0000	T
1303	METHYL ESTER FATTY ACIDS	s	630.0000	T
		e	565.0000	T
1304	PALMITIC ACID	s	800.0000	T
1305	OLEIC ACID	s	1100.0000	T
		e	1000.0000	T
1306	STEARIC ACID	s	1100.0000	T
		e	900.0000	T
1307	BUTYL OLEATE	s	1800.0000	T
		e	1600.0000	T
1308	BUTYL STEARATE	s	1600.0000	T
		e	1400.0000	T
1309	2-ETHYL HEXYL OLEATE	s	1800.0000	T
		e	1600.0000	T
1310	2-ETHYL HEXYL STEARATE	s	1600.0000	T
		e	1400.0000	T
1311	STEARIC GLYCOL ESTER	s	1500.0000	T
		e	1350.0000	T

1312	LAURYL GLYCOL ETHER	s	2000.0000 T
		e	1800.0000 T
1313	OLEIC ETHOXYLATE	s	1400.0000 T
		e	1250.0000 T
1314	ALUMINIUM STEARATE	s	3300.0000 T
		e	3000.0000 T
1315	BARIUM STEARATE	s	2800.0000 T
		e	2600.0000 T
1316	MAGNESIUM STEARATE	s	2800.0000 T
		e	2550.0000 T
1317	ZINC STEARATE	s	2800.0000 T
		e	2550.0000 T
1318	CALCIUM STEARATE	s	2800.0000 T
		e	2550.0000 T
1319	AMMONIUM LAURYL SULFATE SODIUM SALT	s	1200.0000 T
		e	1000.0000 T
1320	TEA LAURYL ETHOXYSULFATE	s	1800.0000 T
		e	1650.0000 T
1321	NONYLPHENOL ETHOXYSULFATE SODIUM SALT	s	1900.0000 T
		e	1750.0000 T
1323	POLYGLYCEROLS (MIXED)	s	850.0000 T
1324	MONOMETHYL ETHER	s	500.0000 T
1325	OLEIC (80%)/LINOLEIC (20%) ACIDS	s	700.0000 T
1326	LINOLEIC ACID	s	700.0000 T
1327	POLYGLYCEROL STEARATE	s	2750.0000 T
		e	2500.0000 T
1328	POLYGLYCEROL OLEATE	s	2600.0000 T
		e	2350.0000 T
1329	DI-GLYCEROL STEARATE	s	2750.0000 T
		e	2500.0000 T
1330	DI-GLYCEROL OLEATE	s	2600.0000 T
		e	2350.0000 T
1331	DOWTHERM	p	40.0000 GJ
1332	ZINC (DUST)	i	1800.0000 T
1333	CHLOROSULFONIC ACID	p	350.0000 T
1334	CNO/PKO FATTY ACIDS (TOPS/BOTTOMS)	s	800.0000 T

MARKET CODE:

p - domestic raw material
i - imported raw material
e - exported product
s - domestic consumption

Annex V. List of technology sources

ALKYLBENZENE, ALKYLBENZENE SULPONATES

Amoco Corproration, USA
Ausidet SRI, Italy
Biachemi Ltd., UK
Petroquimica Espanola, SA Spain
EniChem Augusta SpA Italy
Nippon Petrochemical Co. Ltd., Japan
Petrosynthese SA, France
Synfina Olefina, SA, Belgium
Vista Chemical Company, Texas, USA

OLEATES/STEARATES

AB Nordbakels, Sweden
Etablissment Tiscco SA, France
FACI Srl, Italy
Industrial Chemistry Research Institute, Poland
Greven Peter Fett
Chemie GmbH, Germany
Mosselman NV, Belgium
Migoshi Oil&Fat Co., Japan
Nippon Fine Chemicals Co. Ltd. Japan
Sakai Chemical Industries Co. Ltd., Japan
OLEIC ACID/STEARIC ACID
Adeca Argus Chemicals Co Ltd., Japan
Etablissement Robert Ouvrie SA, France
FACI, Sri, Italy
Friedrich Steinfels AG, Switzerland
Kawamura Kasei Industry Co. Ltd., Japan
Siegert & Cie GmbH, Germany
Synfina Olefina SA, Belgium

STEARATES, METALLIC

Ascalia GmbH, Germany
Barlocher Italia, Spa, Italy
Breyer Chemie BV, Netherlands
De Soto Inc. Speciality products Div. Texas, USA
Harcos Durham Chemicals, UK
Hebron SA, Spain

LAURYL ALCOHOL, ETOXYLATES, SULFOETOXYLATES

Albright & Wilson Ltd. UK
Arguelles P SA, Spain
Berol Nobel AB, Sweden
Condea Chemie GmbH, Germany
De Soto Corporation, Texas, USA
Gwandam Corporation, NJ, USA
Henkel KGa, Germany
Kao Corporation, Japan
Lakeland Laboratories, UK
New Japan Chemical Co. Ltd.,Japan
Seradary Researchs Laboratory, Ontario, Canada
Synfina Olefinas SA. Belgium
Teneco Espana SA, Spain

Over 2000 companies worldwide operates surfactants/oleochemicals processes. The above mentioned list is an exemplifaction of the sources balanced on the regions.

The addresses of the commpanies and their production profile is given in the reference books: Chemical Sources USA, 1992 and Chemical Industry Europe 1993, World Chemical Producers, 1993.

Annex VI. Simulation experiments repsults

Main results comparizon (in million USD):

	MAXNAT	MAXSYNTH	INVMIN	LOCSUP	RATIO	RISK	DEBT
PDA Yearly Profit	1249	1081	606	547	844	550	732
PDA Value Added	2097	1904	906	844	1305	984	1306
Investment	3044	3089	1000	998	1600	1600	1600
Yearly Import	226	206	83	95	114	114	114
Yearly Export	2337	1950	554	0	914	758	914
Yearly Production Value	6753	6302	2432	2247	3679	3729	3679

Main results of experiments

EXPERIMENT "MAXNAT" -- MAIN RESULTS

Fixed Capital Investment - FCI :	3044.496 mln.$	
Production Profit :	1249.139 mln.$	
Simple Rate of Return :	0.39	(2.5 years)
Production Import :	226.443 mln.$	
Domestic Sale of Production :	1390.844 mln.$	
Manufact. Value Added - MVA :	2071.882 mln.$	
MVA/FCI :	0.653	
Gross Production Value - GPV :	6753.322 mln.$	
MVA/GPV :	0.307	
Export :	2336.925 mln.$	
Domestic Purchase :	1326.335 mln.$	

EXPERIMENT "MAXSYNTH" -- MAIN RESULTS

Fixed Capital Investment - FCI :	3089.025 mln.$	
Production Profit :	1080.931 mln.$	
Simple Rate of Return :	0.33	(3.0 years)
Production Import :	205.763 mln.$	
Domestic Sale of Production :	1369.350 mln.$	
Manufact. Value Added - MVA :	1878.805 mln.$	
MVA/FCI :	0.584	
Gross Production Value - GPV :	6302.017 mln.$	
MVA/GPV :	0.298	
Export :	1949.857 mln.$	
Domestic Purchase :	1130.082 mln.$	

EXPERIMENT "LOCSUP" -- MAIN RESULTS

Fixed Capital Investment - FCI :	998.563 mln.$	
Production Profit :	547.242 mln.$	
Simple Rate of Return :	0.47	(2.1 years)
Production Import :	95.172 mln.$	
Domestic Sale of Production :	1474.442 mln.$	
Manufact. Value Added - MVA :	832.341 mln.$	
MVA/FCI :	0.723	
Gross Production Value - GPV :	2247.124 mln.$	
MVA/GPV :	0.370	
Export :	0.000 mln.$	
Domestic Purchase :	509.530 mln.$	

EXPERIMENT "INVMIN" - MAIN RESULTS

Fixed Capital Investment - FCI :	1000.000 mln.$	
Production Profit :	606.500 mln.$	
Simple Rate of Return :	0.52	(1.9 years)
Production Import :	83.424 mln.$	
Domestic Sale of Production :	895.248 mln.$	
Manufact. Value Added - MVA :	894.850 mln.$	
MVA/FCI :	0.777	
Gross Production Value - GPV :	2432.702 mln.$	
MVA/GPV :	0.368	
Export :	554.589 mln.$	
Domestic Purchase :	434.117 mln.$	

EXPERIMENT "RATIO" -- MAIN RESULTS

Fixed Capital Investment - FCI :	1600.000 mln.$	
Production Profit :	843.655 mln.$	
Simple Rate of Return :	0.48	(2.0 years)
Production Import :	114.443 mln.$	
Domestic Sale of Production :	1238.313 mln.$	
Manufact. Value Added - MVA :	1289.769 mln.$	
MVA/FCI :	0.746	
Gross Production Value - GPV :	3679.143 mln.$	
MVA/GPV :	0.350	
Export :	914.375 mln.$	
Domestic Purchase :	692.313 mln.$	

EXPERIMENT "DEBT" - MAIN RESULTS

Fixed Capital Investment - FCI :	1600.000 mln.$	
Production Profit :	731.655 mln.$	
Simple Rate of Return :	0.42	(2.4 years)
Production Import :	114.443 mln.$	
Domestic Sale of Production :	1238.313 mln.$	
Manufact. Value Added - MVA :	1289.769 mln.$	
MVA/FCI :	0.746	
Gross Production Value - GPV :	3679.143 mln.$	
MVA/GPV :	0.350	
Export :	914.375 mln.$	
Domestic Purchase :	692.313 mln.$	

EXPERIMENT "RISC" -- MAIN RESULTS

Fixed Capital Investment - FCI :	1600.000 mln.$	
Production Profit :	549.816 mln.$	
Simple Rate of Return :	0.31	(3.2 years)
Production Import :	113.768 mln.$	
Domestic Sale of Production :	1038.648 mln.$	
Manufact. Value Added - MVA :	968.009 mln.$	
MVA/FCI :	0.552	
Gross Production Value - GPV :	3729.516 mln.$	
MVA/GPV :	0.260	
Export :	758.159 mln.$	
Domestic Purchase :	658.085 mln.$	

Experiment : MAXNAT

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Problem title:    OLEOCHEMICALS and SURFACTANTS PDA

                    S i n g l e  Objective Optimization

Maximize:
        PDA Yearly Profit                               1249.139 mil.$

Scenario:

 .00E+00 <   Investment                           <     none (    .0%) mil.$
 .00E+00 <   Yearly Import                        < 1.00E+14 (    .0%) mil.$
      0. < e 2-ETHYL HEXYL OLEATE                 <    8000. (100.0%) T
      0. < e 2-ETHYL HEXYL STEARATE               <    8000. (100.0%) T
      0. < e ALUMINIUM STEARATE                   <   30000. (100.0%) T
      0. < e AMMONIUM LAURYL SULFATE SODIUM SALT  <   20000. (100.0%) T
      0. < e BARIUM STEARATE                      <   40000. (100.0%) T
      0. < e BUTYL OLEATE                         <   20000. (100.0%) T
      0. < e BUTYL STEARATE                       <   20000. (100.0%) T
      0. < e CALCIUM STEARATE                     <   25000. (100.0%) T
      0. < e CNO/PKO FATTY ACIDS (TOPS/BOTOMS)    <  150000. ( 95.7%) T
      0. < e DI-GLYCEROL OLEATE                   <    3000. (100.0%) T
      0. < e DI-GLYCEROL STEARATE                 <    6000. (100.0%) T
      0. < e FATTY AMINES ETHOXYLATE              <   15000. (100.0%) T
      0. < e LAURYL ALCOHOL ETHOXYLATE            <   80000. (100.0%) T
      0. < e LAURYL ALCOHOL ETHOXYSULFONATE Na    <   60000. (100.0%) T
      0. < e LAURYL ALCOHOL SULFONATE SODIUM SALT <   60000. (100.0%) T
      0. < e LAURYL GLYCOL ETHER                  <   10000. (100.0%) T
      0. < e MAGNESIUM STEARATE                   <   15000. (100.0%) T
      0. < e METHYL ESTER FATTY ACIDS             <   60000. (100.0%) T
      0. < e NONYLPHENOL ETHOXYSULFATE SODIUM SALT <  20000. (100.0%) T
      0. < e OLEIC ACID                           <  150000. (100.0%) T
      0. < e OLEIC ETHOXYLATE                     <   20000. (100.0%) T
      0. < e PALM OIL FATTY ACIDS PRIMARY AMINES  <   15000. (100.0%) T
      0. < e POLYGLYCEROL OLEATE                  <    1000. (100.0%) T
      0. < e POLYGLYCEROL STEARATE                <    4000. (100.0%) T
      0. < e PRIMARY ALCOHOLS LINEAR, C12 & C14   <  160000. (100.0%) T
      0. < e SOAP                                 <  500000. (100.0%) T
      0. < e SODIUM ALKYLBENZYL SULFONATE         <   90000. (100.0%) T
      0. < e STEARIC ACID                         <  150000. ( 97.6%) T
      0. < e STEARIC GLYCOL ESTER                 <    4000. (100.0%) T
      0. < e TEA LAURYL ETHOXYSULFATE             <   20000. (100.0%) T
      0. < e TEA LAURYL SULFATE                   <   20000. (100.0%) T
      0. < e ZINC STEARATE                        <   45000. (100.0%) T
      0. < p COCONUT/PALM KERNEL OIL              <  960000. ( 91.8%) T
      0. < p PALM OIL                             < 2000000. ( 73.6%) T
      0. < s 2-ETHYL HEXYL OLEATE                 <    2000. (100.0%) T
      0. < s 2-ETHYL HEXYL STEARATE               <    2000. (100.0%) T
      0. < s ALUMINIUM STEARATE                   <    3000. (100.0%) T
      0. < s AMMONIUM LAURYL SULFATE SODIUM SALT  <   10000. (100.0%) T
      0. < s BARIUM STEARATE                      <    4000. (100.0%) T
      0. < s BUTYL OLEATE                         <    3000. (100.0%) T
      0. < s BUTYL STEARATE                       <    6000. (100.0%) T
      0. < s CALCIUM STEARATE                     <    6000. (100.0%) T
      0. < s CNO/PKO FATTY ACIDS (TOPS/BOTOMS)    <   30000. (100.0%) T
      0. < s DI-GLYCEROL OLEATE                   <    1000. (100.0%) T
      0. < s DI-GLYCEROL STEARATE                 <    2000. (100.0%) T
```

0.	<	s	FATTY AMINES ETHOXYLATE	<	4000.	(100.0%)	T
0.	<	s	GLYCERIN	<	30000.	(100.0%)	T
0.	<	s	LAURYL ALCOHOL ETHOXYLATE	<	75000.	(100.0%)	T
0.	<	s	LAURYL ALCOHOL ETHOXYSULFONATE Na	<	90000.	(100.0%)	T
0.	<	s	LAURYL ALCOHOL SULFONATE SODIUM SALT	<	70000.	(100.0%)	T
0.	<	s	LAURYL GLYCOL ETHER	<	2500.	(100.0%)	T
0.	<	s	MAGNESIUM STEARATE	<	1500.	(100.0%)	T
0.	<	s	METHYL ESTER FATTY ACIDS	<	40000.	(100.0%)	T
0.	<	s	NONYLPHENOL ETHOXYLATE	<	15000.	(100.0%)	T
0.	<	s	NONYLPHENOL ETHOXYSULFATE SODIUM SALT	<	30000.	(100.0%)	T
0.	<	s	OLEIC ACID	<	15000.	(100.0%)	T
0.	<	s	OLEIC ETHOXYLATE	<	5000.	(100.0%)	T
0.	<	s	PALM OIL FATTY ACIDS PRIMARY AMINES	<	4000.	(100.0%)	T
0.	<	s	POLYGLYCEROL OLEATE	<	1000.	(100.0%)	T
0.	<	s	POLYGLYCEROL STEARATE	<	2000.	(100.0%)	T
0.	<	s	PRIMARY ALCOHOLS LINEAR, C12 & C14	<	20000.	(100.0%)	T
0.	<	s	SOAP	<	520000.	(100.0%)	T
0.	<	s	SODIUM ALKYLBENZYL SULFONATE	<	140000.	(100.0%)	T
0.	<	s	STEARIC ACID	<	25000.	(100.0%)	T
0.	<	s	STEARIC GLYCOL ESTER	<	2000.	(100.0%)	T
0.	<	s	TEA LAURYL ETHOXYSULFATE	<	5000.	(100.0%)	T
0.	<	s	TEA LAURYL SULFATE	<	5000.	(100.0%)	T
0.	<	s	ZINC STEARATE	<	4500.	(100.0%)	T

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G L O B A L   R E S U L T S

PDA Yearly Profit	1249.	mil.$
PDA Value Added	2097.	mil.$
Investment	3044.	mil.$
Yearly Import	226.	mil.$
Yearly Export	2337.	mil.$
Yearly Domestic Purchase	1326.	mil.$
Yearly Domestic Sale	1391.	mil.$

E X P O R T

2-ETHYL HEXYL OLEATE	8000.	T
2-ETHYL HEXYL STEARATE	8000.	T
ALUMINIUM STEARATE	30000.	T
AMMONIUM LAURYL SULFATE SODIUM SALT	20000.	T
BARIUM STEARATE	40000.	T
BUTYL OLEATE	20000.	T
BUTYL STEARATE	20000.	T
CALCIUM STEARATE	25000.	T
CNO/PKO FATTY ACIDS (TOPS/BOTOMS)	143560.	T
DI-GLYCEROL OLEATE	3000.	T
DI-GLYCEROL STEARATE	6000.	T
FATTY AMINES ETHOXYLATE	15000.	T
GLYCERIN	185247.	T
LAURYL ALCOHOL ETHOXYLATE	80000.	T
LAURYL ALCOHOL ETHOXYSULFONATE Na	60000.	T
LAURYL ALCOHOL SULFONATE SODIUM SALT	60000.	T
LAURYL GLYCOL ETHER	10000.	T
MAGNESIUM STEARATE	15000.	T
METHYL ESTER FATTY ACIDS	60000.	T
NONYLPHENOL ETHOXYSULFATE SODIUM SALT	20000.	T

OLEIC ACID	150000.	T
OLEIC ETHOXYLATE	20000.	T
PALM OIL FATTY ACIDS PRIMARY AMINES	15000.	T
POLYGLYCEROL OLEATE	1000.	T
POLYGLYCEROL STEARATE	4000.	T
PRIMARY ALCOHOLS LINEAR, C12 & C14	160000.	T
SOAP	500000.	T
SODIUM ALKYLBENZYL SULFONATE	90000.	T
STEARIC ACID	146458.	T
STEARIC GLYCOL ESTER	4000.	T
TEA LAURYL ETHOXYSULFATE	20000.	T
TEA LAURYL SULFATE	20000.	T
ZINC STEARATE	45000.	T

I M P O R T

2-ETHYLHEXANOL	6750.	T
ACETIC ACID	282.	T
ALUMINA TRIHYDRATE	3300.	T
ALUMINUM PELLETS	667.	T
BARIUM CARBONATE	13200.	T
BORON TRIFLUORIDE	18.	T
CALCIUM CARBONATE	5580.	T
CATALYST AND CHEMICALS	41227568.	USD
CHEMICALS	427718.	USD
HEPTANE	15.	T
MAGNESIUM OXIDE	1980.	T
N-BUTANOL	11875.	T
PHENOL	8327.	T
POTASSIUM CARBONATE	334.	T
POTASSIUM HYDROXIDE	133116.	T
SILICA GEL	299.	T
TITANIUM DIOXIDE	2040.	T
ZINC (DUST)	5197.	T

DOMESTIC P U R C H A S E

AMMONIA	10965.	T
BENZENE	70564.	T
CALCIUM CHLORIDE	1002.	T
CHLOROSULFONIC ACID	18110.	T
COCONUT/PALM KERNEL OIL	881013.	T
COOLING WATER	336520928.	M3
DOWTHERM	24000.	GJ
ELECTRICITY	1079955456.	KWH
ETHYLENE	159461.	T
HYDROCHLORIC ACID	4381.	T
HYDROGEN (97 VOL %)	95848504.	M3
INERT GAS	64916072.	NM3
METHANE	29781172.	NM3
METHANOL	114351.	T
N-PARAFFINS C10-C13	134021.	T
NATURAL GAS	747124544.	T-CAL
NONENE (PROPYLENE TRIMER)	11310.	T
OXYGEN (MODERATE USAGE)	191634.	T
PALM OIL	1472482.	T
PHOSPHORIC ACID (INDUSTRIAL GRADE)	72.	T
PROCESS WATER	35815020.	M3

SALT	132973.	T
SODIUM CHLORIDE	5100.	T
STEAM	7306425.	T
SULFUR	42006.	T
SULFUR TRIOXIDE	56879.	T

DOMESTIC S A L E

2-ETHYL HEXYL OLEATE	2000.	T
2-ETHYL HEXYL STEARATE	2000.	T
ALUMINIUM STEARATE	3000.	T
AMMONIUM LAURYL SULFATE SODIUM SALT	10000.	T
BARIUM STEARATE	4000.	T
BUTYL OLEATE	3000.	T
BUTYL STEARATE	6000.	T
CALCIUM STEARATE	6000.	T
CARBON DIOXIDE	105579.	T
CAUSTIC SODA	11855.	T
CNO/PKO FATTY ACIDS (TOPS/BOTOMS)	30000.	T
DI-GLYCEROL OLEATE	1000.	T
DI-GLYCEROL STEARATE	2000.	T
DIETHANOLAMINE	1295.	T
FATTY AMINES ETHOXYLATE	4000.	T
FUEL GAS	21081646.	T-CAL
GLYCERIN	30000.	T
HYDROGEN AS FUEL	70369928.	T-CAL
LAURYL ALCOHOL ETHOXYLATE	75000.	T
LAURYL ALCOHOL ETHOXYSULFONATE Na	90000.	T
LAURYL ALCOHOL SULFONATE SODIUM SALT	70000.	T
LAURYL GLYCOL ETHER	2500.	T
MAGNESIUM STEARATE	1500.	T
METHYL ESTER FATTY ACIDS	40000.	T
MONOETHANOLAMINE	555.	T
NONYLPHENOL ETHOXYLATE	15000.	T
NONYLPHENOL ETHOXYSULFATE SODIUM SALT	30000.	T
OLEIC ACID	15000.	T
OLEIC ETHOXYLATE	5000.	T
PALM OIL FATTY ACIDS PRIMARY AMINES	4000.	T
POLYGLYCEROL OLEATE	1000.	T
POLYGLYCEROL STEARATE	2000.	T
POLYGLYCEROLS (MIXED)	2660.	T
PRIMARY ALCOHOLS LINEAR, C12 & C14	20000.	T
SOAP	520000.	T
SODIUM ALKYLBENZYL SULFONATE	140000.	T
STEARIC ACID	25000.	T
STEARIC GLYCOL ESTER	2000.	T
SULFURIC ACID(IN 65%)	675.	T
TEA LAURYL ETHOXYSULFATE Na	5000.	T
TEA LAURYL SULFATE SODIUM SALT	5000.	T
ZINC STEARATE	4500.	T

P R O C E S S E S

2-ETHYLHEXYL OLEATE	10000.	T
2-ETHYLHEXYL STEARATE	10000.	T
ALLUMINIUM STEARATE	33000.	T
AMMONIUM LAURYL SULFATE	30000.	T
BARIUM STEARATE	44000.	T

BUTYL OLEATE	23000.	T
BUTYL STEARATE	26000.	T
CALCIUM STEARATE	31000.	T
CHLORINE (USING DIAPHRAGM CELLS)	77671.	T
DI-GLYCEROL OLEATE	4000.	T
DI-GLYCEROL STEARATE	8000.	T
EO BY ETHYLENE OXYGEN OXIDATION	189925.	T
ETHANOLAMINES FROM AMMONIA AND EO	18500.	T
FATTY ACIDS FROM PALM OIL (HYDROLYSIS)	1155995.	T
FATTY AMINES ETHOXYLATE	19000.	T
FATTY AMINES FROM PALM OIL FATTY ACIDS	25137.	T
HYDRGENATION OF FATTY ACIDS	302285.	T
HYDROGENATION OF FATTY ACIDS	72700.	T
LAURYL GLYCOL ETHER	12500.	T
MAGNESIUM STEARATE	16500.	T
METHYL ESTERS FATTY ACIDS	100000.	T
MONOMETHYL ETHER	1500.	T
NONYLPHENOL ETHOXYLATE NONIONIC SURFACT.	53500.	T
NONYLPHENOL ETHOXYSULFATE SODIUM SALT	50000.	T
OLEIC ACID (PO FATTY ACID DISTILLATION)	207715.	T
OLEIC/LINOLEIC ACID (PO FATTY ACID DIST)	302285.	T
OLEIN ETHOXYLATE	15000.	T
P-NONYLPHENOL (A BORON TRIFLUORIDE CAT.)	19324.	T
POLYGLYCEROL OLEATE	2000.	T
POLYGLYCEROL STEARATE	6000.	T
PRIMARY ALCOHOL ETHOXYLATE	281700.	T
PRIMARY ALCOHOL ETOXYSULFONATE	150000.	T
PRIMARY ALCOHOL SULFONATE	130000.	T
PRIMARY ALCOHOLS, LINEAR C12&C14	469080.	T
SOAP FROM PALMITIC ACID (CONT. METH.)	1020000.	T
SOD. ALKYLBENZYL SULFONATE FROM N-PARAF.	230000.	T
STEARIC GLYCOL ESTER	6000.	T
SULFURIC ACID FROM SULFUR	32608.	T
TRIETANOLAMINE LAURYL ETHOXY SULFATE	25000.	T
TRIETANOLAMINE LAURYL SULFATE	25000.	T
ZINC STEARATE	49500.	T

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Experiment : MAXSYNTH

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Problem title: OLEOCHEMICALS and SURFACTANTS PDA

S i n g l e Objective Optimization

Maximize:

PDA Yearly Profit 1080.931 mil.$

Scenario:

.00E+00	<		Investment	<	none	(.0%)	mil.$
.00E+00	<		Yearly Import	<	1.00E+14	(.0%)	mil.$
0.	<	e	2-ETHYL HEXYL OLEATE	<	8000.	(100.0%)	T
0.	<	e	2-ETHYL HEXYL STEARATE	<	8000.	(100.0%)	T
0.	<	e	ALUMINIUM STEARATE	<	30000.	(100.0%)	T
0.	<	e	AMMONIUM LAURYL SULFATE SODIUM SALT	<	20000.	(100.0%)	T
0.	<	e	BARIUM STEARATE	<	40000.	(100.0%)	T
0.	<	e	BUTYL OLEATE	<	20000.	(100.0%)	T
0.	<	e	BUTYL STEARATE	<	20000.	(100.0%)	T
0.	<	e	CALCIUM STEARATE	<	25000.	(100.0%)	T
0.	<	e	CNO/PKO FATTY ACIDS (TOPS/BOTOMS)	<	150000.	(.0%)	T
0.	<	e	DI-GLYCEROL OLEATE	<	3000.	(100.0%)	T
0.	<	e	DI-GLYCEROL STEARATE	<	6000.	(100.0%)	T
0.	<	e	FATTY AMINES ETHOXYLATE	<	15000.	(100.0%)	T
0.	<	e	LAURYL ALCOHOL ETHOXYLATE	<	80000.	(100.0%)	T
0.	<	e	LAURYL ALCOHOL ETHOXYSULFONATE Na	<	60000.	(100.0%)	T
0.	<	e	LAURYL ALCOHOL SULFONATE SODIUM SALT	<	60000.	(100.0%)	T
0.	<	e	LAURYL GLYCOL ETHER	<	10000.	(100.0%)	T
0.	<	e	MAGNESIUM STEARATE	<	15000.	(100.0%)	T
0.	<	e	METHYL ESTER FATTY ACIDS	<	60000.	(100.0%)	T
0.	<	e	NONYLPHENOL ETHOXYSULFATE SODIUM SALT	<	20000.	(100.0%)	T
0.	<	e	OLEIC ACID	<	150000.	(100.0%)	T
0.	<	e	OLEIC ETHOXYLATE	<	20000.	(100.0%)	T
0.	<	e	PALM OIL FATTY ACIDS PRIMARY AMINES	<	15000.	(100.0%)	T
0.	<	e	POLYGLYCEROL OLEATE	<	1000.	(100.0%)	T
0.	<	e	POLYGLYCEROL STEARATE	<	4000.	(100.0%)	T
0.	<	e	PRIMARY ALCOHOLS LINEAR, C12-C15	<	160000.	(.0%)	T
0.	<	e	SOAP	<	500000.	(100.0%)	T
0.	<	e	SODIUM ALKYLBENZYL SULFONATE	<	90000.	(100.0%)	T
0.	<	e	STEARIC ACID	<	150000.	(97.6%)	T
0.	<	e	STEARIC GLYCOL ESTER	<	4000.	(100.0%)	T
0.	<	e	TEA LAURYL ETHOXYSULFATE	<	20000.	(100.0%)	T
0.	<	e	TEA LAURYL SULFATE	<	20000.	(100.0%)	T
0.	<	e	ZINC STEARATE	<	45000.	(100.0%)	T
0.	<	p	COCONUT/PALM KERNEL OIL	<	960000.	(15.9%)	T
0.	<	p	PALM OIL	<	2000000.	(73.6%)	T
0.	<	s	2-ETHYL HEXYL OLEATE	<	2000.	(100.0%)	T
0.	<	s	2-ETHYL HEXYL STEARATE	<	2000.	(100.0%)	T
0.	<	s	ALUMINIUM STEARATE	<	3000.	(100.0%)	T
0.	<	s	AMMONIUM LAURYL SULFATE SODIUM SALT	<	10000.	(100.0%)	T
0.	<	s	BARIUM STEARATE	<	4000.	(100.0%)	T
0.	<	s	BUTYL OLEATE	<	3000.	(100.0%)	T
0.	<	s	BUTYL STEARATE	<	6000.	(100.0%)	T
0.	<	s	CALCIUM STEARATE	<	6000.	(100.0%)	T
0.	<	s	CNO/PKO FATTY ACIDS (TOPS/BOTOMS)	<	30000.	(.0%)	T
0.	<	s	DI-GLYCEROL OLEATE	<	1000.	(100.0%)	T
0.	<	s	DI-GLYCEROL STEARATE	<	2000.	(100.0%)	T

0.	< s	FATTY AMINES ETHOXYLATE	<	4000.	(100.0%) T
0.	< s	GLYCERIN	<	30000.	(100.0%) T
0.	< s	LAURYL ALCOHOL ETHOXYLATE	<	75000.	(100.0%) T
0.	< s	LAURYL ALCOHOL ETHOXYSULFONATE Na	<	90000.	(100.0%) T
0.	< s	LAURYL ALCOHOL SULFONATE SODIUM SALT	<	70000.	(100.0%) T
0.	< s	LAURYL GLYCOL ETHER	<	2500.	(100.0%) T
0.	< s	MAGNESIUM STEARATE	<	1500.	(100.0%) T
0.	< s	METHYL ESTER FATTY ACIDS	<	40000.	(100.0%) T
0.	< s	NONYLPHENOL ETHOXYLATE	<	15000.	(100.0%) T
0.	< s	NONYLPHENOL ETHOXYSULFATE SODIUM SALT	<	30000.	(100.0%) T
0.	< s	OLEIC ACID	<	15000.	(100.0%) T
0.	< s	OLEIC ETHOXYLATE	<	5000.	(100.0%) T
0.	< s	PALM OIL FATTY ACIDS PRIMARY AMINES	<	4000.	(100.0%) T
0.	< s	POLYGLYCEROL OLEATE	<	1000.	(100.0%) T
0.	< s	POLYGLYCEROL STEARATE	<	2000.	(100.0%) T
0.	< s	PRIMARY ALCOHOLS LINEAR, C12-C15	<	20000.	(100.0%) T
0.	< s	SOAP	<	520000.	(100.0%) T
0.	< s	SODIUM ALKYLBENZYL SULFONATE	<	140000.	(100.0%) T
0.	< s	STEARIC ACID	<	25000.	(100.0%) T
0.	< s	STEARIC GLYCOL ESTER	<	2000.	(100.0%) T
0.	< s	TEA LAURYL ETHOXYSULFATE	<	5000.	(100.0%) T
0.	< s	TEA LAURYL SULFATE	<	5000.	(100.0%) T
0.	< s	ZINC STEARATE	<	4500.	(100.0%) T

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G L O B A L   R E S U L T S

PDA Yearly Profit	1081.	mil.$
PDA Value Added	1904.	mil.$
Investment	3089.	mil.$
Yearly Import	206.	mil.$
Yearly Export	1950.	mil.$
Yearly Domestic Purchase	1130.	mil.$
Yearly Domestic Sale	1369.	mil.$

E X P O R T

2-ETHYL HEXYL OLEATE	8000.	T
2-ETHYL HEXYL STEARATE	8000	T
ALUMINIUM STEARATE	30000.	T
AMMONIUM LAURYL SULFATE SODIUM SALT	20000.	T
BARIUM STEARATE	40000.	T
BUTYL OLEATE	20000.	T
BUTYL STEARATE	20000.	T
CALCIUM STEARATE	25000.	T
DI-GLYCEROL OLEATE	3000.	T
DI-GLYCEROL STEARATE	6000.	T
FATTY AMINES ETHOXYLATE	15000.	T
GLYCERIN	84723.	T
LAURYL ALCOHOL ETHOXYLATE	80000.	T
LAURYL ALCOHOL ETHOXYSULFONATE Na	60000.	T
LAURYL ALCOHOL SULFONATE SODIUM SALT	60000.	T
LAURYL GLYCOL ETHER	10000.	T
MAGNESIUM STEARATE	15000.	T
METHYL ESTER FATTY ACIDS	60000.	T
NONYLPHENOL ETHOXYSULFATE SODIUM SALT	20000.	T

OLEIC ACID	150000.	T
OLEIC ETHOXYLATE	20000.	T
PALM OIL FATTY ACIDS PRIMARY AMINES	15000.	T
POLYGLYCEROL OLEATE	1000.	T
POLYGLYCEROL STEARATE	4000.	T
SOAP	500000.	T
SODIUM ALKYLBENZYL SULFONATE	90000.	T
STEARIC ACID	146458.	T
STEARIC GLYCOL ESTER	4000.	T
TEA LAURYL ETHOXYSULFATE	20000.	T
TEA LAURYL SULFATE	20000.	T
ZINC STEARATE	45000.	T

I M P O R T

2-ETHYLHEXANOL	6750.	T
ACETIC ACID	282.	T
ALUMINA TRIHYDRATE	3300.	T
ALUMINUM PELLETS	667.	T
BARIUM CARBONATE	13200.	T
BORON TRIFLUORIDE	18.	T
CALCIUM CARBONATE	5580.	T
CATALYST AND CHEMICALS	5392191.	USD
CHEMICALS	16036280.	USD
HEPTANE	15.	T
MAGNESIUM OXIDE	1980.	T
MOLECULAR SIEVES	3.	T
N-BUTANOL	11875.	T
PHENOL	8327.	T
POTASSIUM CARBONATE	334.	T
POTASSIUM HYDROXIDE	132649.	T
SILICA GEL	299.	T
TITANIUM DIOXIDE	2040.	T
ZINC (DUST)	5197.	T

DOMESTIC P U R C H A S E

AMMONIA	10965.	T
BENZENE	73438.	T
CALCIUM CHLORIDE	1002.	T
CAUSTIC SODA	9780.	T
CHLOROSULFONIC ACID	18110.	T
COCONUT/PALM KERNEL OIL	153000.	T
COOLING WATER	446494048.	M3
DOWTHERM	24000.	GJ
ELECTRICITY	1129336320.	KWH
ETHYLENE	486604.	T
HYDROCHLORIC ACID	4381.	T
HYDROGEN (97 VOL %)	95848504.	M3
INERT GAS	86313736.	NM3
METHANE	29781172.	NM3
METHANOL	20465.	T
N-PARAFFINS C10-C13	134021.	T
NATURAL GAS	1069764928.	T-CAL
NONENE (PROPYLENE TRIMER)	11310.	T
OXYGEN (MODERATE USAGE)	191634.	T
PALM OIL	1472482.	T
PHOSPHORIC ACID (INDUSTRIAL GRADE)	72.	T

PROCESS WATER	35386292.	M3
SALT	132973.	T
SODIUM CHLORIDE	5100.	T
STEAM	9028544.	T
SULFUR	41391.	T
SULFUR TRIOXIDE	56879.	T

DOMESTIC S A L E

2-ETHYL HEXYL OLEATE	2000.	T
2-ETHYL HEXYL STEARATE	2000.	T
ALUMINIUM STEARATE	3000.	T
AMMONIUM LAURYL SULFATE SODIUM SALT	10000.	T
BARIUM STEARATE	4000.	T
BUTYL OLEATE	3000.	T
BUTYL STEARATE	6000.	T
CALCIUM STEARATE	6000.	T
CARBON DIOXIDE	105579.	T
DI-GLYCEROL OLEATE	1000.	T
DI-GLYCEROL STEARATE	2000.	T
DIETHANOLAMINE	1295.	T
FATTY AMINES ETHOXYLATE	4000.	T
FUEL GAS	107006008.	T-CAL
FUEL LIQUID	446312160.	T-CAL
GLYCERIN	30000.	T
HYDROGEN AS FUEL	70369928.	T-CAL
LAURYL ALCOHOL ETHOXYLATE	75000.	T
LAURYL ALCOHOL ETHOXYSULFONATE Na	90000.	T
LAURYL ALCOHOL SULFONATE SODIUM SALT	70000.	T
LAURYL GLYCOL ETHER	2500.	T
MAGNESIUM STEARATE	1500.	T
METHYL ESTER FATTY ACIDS	40000.	T
MONOETHANOLAMINE	550.	T
NONYLPHENOL ETHOXYLATE	15000.	T
NONYLPHENOL ETHOXYSULFATE SODIUM SALT	30000.	T
OLEIC ACID	15000.	T
OLEIC ETHOXYLATE	5000.	T
PALM OIL FATTY ACIDS PRIMARY AMINES	4000.	T
POLYGLYCEROL OLEATE	1000.	T
POLYGLYCEROL STEARATE	2000.	T
POLYGLYCEROLS (MIXED)	2660.	T
PRIMARY ALCOHOLS LINEAR, C12-C15	20000.	T
SOAP	520000.	T
SODIUM ALKYLBENZYL SULFONATE	140000.	T
STEARIC ACID	25000.	T
STEARIC GLYCOL ESTER	2000.	T
SULFURIC ACID(IN 65%)	675.	T
TEA LAURYL ETHOXYSULFATE	5000.	T
TEA LAURYL SULFATE	5000.	T
ZINC STEARATE	4500.	T

P R O C E S S E S

2-ETHYLHEXYL OLEATE	10000.	T
2-ETHYLHEXYL STEARATE	10000.	T
ALLUMINIUM STEARATE	33000.	T
AMMONIUM LAURYL SULFATE	30000.	T
BARIUM STEARATE	44000.	T

BUTYL OLEATE	23000.	T
BUTYL STEARATE	26000.	T
CALCIUM STEARATE	31000.	T
CHLORINE (USING DIAPHRAGM CELLS)	77671.	T
DI-GLYCEROL OLEATE	4000.	T
DI-GLYCEROL STEARATE	8000.	T
EO BY ETHYLENE OXYGEN OXIDATION	189925.	T
ETHANOLAMINES FROM AMMONIA AND EO	18500.	T
FATTY ACIDS FROM PALM OIL (HYDROLYSIS)	1155995.	T
FATTY AMINES ETHOXYLATE	19000.	T
FATTY AMINES FROM PALM OIL FATTY ACIDS	25137.	T
HYDRGENATION OF FATTY ACIDS	302285.	T
HYDROGENATION OF FATTY ACIDS	72700.	T
LAURYL GLYCOL ETHER	12500.	T
MAGNESIUM STEARATE	16500.	T
METHYL ESTERS FATTY ACIDS	100000.	T
MONOMETHYL ETHER	1500.	T
NONYLPHENOL ETHOXYLATE NONIONIC SURFACT.	53500.	T
NONYLPHENOL ETHOXYSULFATE SODIUM SALT	50000.	T
OLEFINS,LINEAR,BY C2H4 OLIGOMERIZATION	311862.	T
OLEIC ACID (PO FATTY ACID DISTILLATION)	207715.	T
OLEIC/LINOLEIC ACID (PO FATTY ACID DIST)	302285.	T
OLEIN ETHOXYLATE	25000.	T
P-NONYLPHENOL (A BORON TRIFLUORIDE CAT.)	19324.	T
POLYGLYCEROL OLEATE	2000.	T
POLYGLYCEROL STEARATE	6000.	T
PRIMARY ALCOHOL ETHOXYLATE	281700.	T
PRIMARY ALCOHOL ETOXYSULFONATE	150000.	T
PRIMARY ALCOHOL SULFONATE	130000.	T
PRIMARY ALCOHOLS, LINEAR, C12-C15	309080.	T
SOAP FROM PALMITIC ACID (CONT. METH.)	1020000.	T
SOD. ALKYLBENZYL SULFONATE FROM N-PARAF.	230000.	T
STEARIC GLYCOL ESTER	6000.	T
SULFURIC ACID FROM SULFUR	30732.	T
SYNTHESIS GAS (2:1) FROM NATURAL GAS	140013.	MNM3
TRIETANOLAMINE LAURYL ETHOXY SULFATE	25000.	T
TRIETANOLAMINE LAURYL SULFATE	25000.	T
ZINC STEARATE	49500.	T

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Experiment : LOCSUP

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Problem title:    OLEOCHEMICALS and SURFACTANTS PDA

                   S i n g l e  Objective Optimization

Maximize:
        PDA Yearly Profit                           547.242 mil.$

Scenario:

 .00E+00 <   Investment                       <     none (     .0%) mil.$
 .00E+00 <   Yearly Import                    < 1.00E+14 (     .0%) mil.$
      0. < e 2-ETHYL HEXYL OLEATE             <    8000. (     .0%) T
      0. < e 2-ETHYL HEXYL STEARATE           <    8000. (     .0%) T
      0. < e ALUMINIUM STEARATE               <   30000. (     .0%) T
      0. < e AMMONIUM LAURYL SULFATE SODIUM SALT <  20000. (   .0%) T
      0. < e BARIUM STEARATE                  <   40000. (     .0%) T
      0. < e BUTYL OLEATE                     <   20000. (     .0%) T
      0. < e BUTYL STEARATE                   <   20000. (     .0%) T
      0. < e CALCIUM STEARATE                 <   25000. (     .0%) T
      0. < e CNO/PKO FATTY ACIDS (TOPS/BOTOMS) <  150000. (    .0%) T
      0. < e DI-GLYCEROL OLEATE               <    3000. (     .0%) T
      0. < e DI-GLYCEROL STEARATE             <    6000. (     .0%) T
      0. < e FATTY AMINES ETHOXYLATE          <   15000. (     .0%) T
      0. < e LAURYL ALCOHOL ETHOXYLATE        <   80000. (     .0%) T
      0. < e LAURYL ALCOHOL ETHOXYSULFONATE Na <   60000. (    .0%) T
      0. < e LAURYL ALCOHOL SULFONATE SODIUM SALT < 60000. (   .0%) T
      0. < e LAURYL GLYCOL ETHER              <   10000. (     .0%) T
      0. < e MAGNESIUM STEARATE               <   15000. (     .0%) T
      0. < e METHYL ESTER FATTY ACIDS         <   60000. (     .0%) T
      0. < e NONYLPHENOL ETHOXYSULFATE SODIUM SALT < 20000. (  .0%) T
      0. < e OLEIC ACID                       <  150000. (     .0%) T
      0. < e OLEIC ETHOXYLATE                 <   20000. (     .0%) T
      0. < e PALM OIL FATTY ACIDS PRIMARY AMINES < 15000. (    .0%) T
      0. < e POLYGLYCEROL OLEATE              <    1000. (     .0%) T
      0. < e POLYGLYCEROL STEARATE            <    4000. (     .0%) T
      0. < e PRIMARY ALCOHOLS LINEAR, C12 & C14 < 160000. (    .0%) T
      0. < e SOAP                             <  500000. (     .0%) T
      0. < e SODIUM ALKYLBENZYL SULFONATE      <   90000. (     .0%) T
      0. < e STEARIC ACID                     <  150000. (     .0%) T
      0. < e STEARIC GLYCOL ESTER             <    4000. (     .0%) T
      0. < e TEA LAURYL ETHOXYSULFATE         <   20000. (     .0%) T
      0. < e TEA LAURYL SULFATE               <   20000. (     .0%) T
      0. < e ZINC STEARATE                    <   45000. (     .0%) T
      0. < p COCONUT/PALM KERNEL OIL          <  960000  (  34.6%) T
      0. < p PALM OIL                         < 2000000. (  24.7%) T
      0. < s 2-ETHYL HEXYL OLEATE             <    2000. (100.0%) T
      0. < s 2-ETHYL HEXYL STEARATE           <    2000. (100.0%) T
      0. < s ALUMINIUM STEARATE               <    3000. (100.0%) T
      0. < s AMMONIUM LAURYL SULFATE SODIUM SALT <  10000. (100.0%) T
      0. < s BARIUM STEARATE                  <    4000. (100.0%) T
      0. < s BUTYL OLEATE                     <    3000. (100.0%) T
      0. < s BUTYL STEARATE                   <    6000. (100.0%) T
      0. < s CALCIUM STEARATE                 <    6000. (100.0%) T
 .00E+00 < s CNO/PKO FATTY ACIDS (TOPS/BOTOMS) <    none (     .0%) T
      0. < s DI-GLYCEROL OLEATE               <    1000. (100.0%) T
      0. < s DI-GLYCEROL STEARATE             <    2000. (100.0%) T
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0.	<	s	FATTY AMINES ETHOXYLATE	<	4000.	(100.0%)	T
0.	<	s	LAURYL ALCOHOL ETHOXYLATE	<	75000.	(100.0%)	T
0.	<	s	LAURYL ALCOHOL ETHOXYSULFONATE Na	<	90000.	(100.0%)	T
0.	<	s	LAURYL ALCOHOL SULFONATE SODIUM SALT	<	70000.	(100.0%)	T
0.	<	s	LAURYL GLYCOL ETHER	<	2500.	(100.0%)	T
0.	<	s	MAGNESIUM STEARATE	<	1500.	(100.0%)	T
0.	<	s	METHYL ESTER FATTY ACIDS	<	40000.	(100.0%)	T
0.	<	s	NONYLPHENOL ETHOXYLATE	<	15000.	(100.0%)	T
0.	<	s	NONYLPHENOL ETHOXYSULFATE SODIUM SALT	<	30000.	(100.0%)	T
0.	<	s	OLEIC ACID	<	15000.	(100.0%)	T
0.	<	s	OLEIC ETHOXYLATE	<	5000.	(100.0%)	T
0.	<	s	PALM OIL FATTY ACIDS PRIMARY AMINES	<	4000.	(100.0%)	T
0.	<	s	POLYGLYCEROL OLEATE	<	1000.	(100.0%)	T
0.	<	s	POLYGLYCEROL STEARATE	<	2000.	(100.0%)	T
0.	<	s	PRIMARY ALCOHOLS LINEAR, C12 & C14	<	20000.	(100.0%)	T
0.	<	s	SOAP	<	520000.	(100.0%)	T
0.	<	s	SODIUM ALKYLBENZYL SULFONATE	<	140000.	(100.0%)	T
0.	<	s	STEARIC ACID	<	25000.	(100.0%)	T
0.	<	s	STEARIC GLYCOL ESTER	<	2000.	(100.0%)	T
0.	<	s	TEA LAURYL ETHOXYSULFATE	<	5000.	(100.0%)	T
0.	<	s	TEA LAURYL SULFATE	<	5000.	(100.0%)	T
0.	<	s	ZINC STEARATE	<	4500.	(100.0%)	T

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G L O B A L   R E S U L T S

PDA Yearly Profit	547.	mil.$
PDA Value Added	844.	mil.$
Investment	999.	mil.$
Yearly Import	95.	mil.$
Yearly Export	0.	mil.$
Yearly Domestic Purchase	510.	mil.$
Yearly Domestic Sale	1474.	mil.$

I M P O R T

2-ETHYLHEXANOL	1350.	T
ACETIC ACID	147.	T
ALUMINA TRIHYDRATE	300.	T
ALUMINUM PELLETS	406.	T
BARIUM CARBONATE	1200.	T
BORON TRIFLUORIDE	13.	T
CALCIUM CARBONATE	1080.	T
CATALYST AND CHEMICALS	13866975.	USD
CHEMICALS	57348.	USD
HEPTANE	11.	T
MAGNESIUM OXIDE	180.	T
N-BUTANOL	2175.	T
PHENOL	5930.	T
POTASSIUM CARBONATE	163.	T
POTASSIUM HYDROXIDE	67780.	T
SILICA GEL	182.	T
TITANIUM DIOXIDE	848.	T
ZINC (DUST)	472.	T

DOMESTIC   P U R C H A S E

AMMONIA	2895.	T
BENZENE	42952.	T
CALCIUM CHLORIDE	610.	T
CHLOROSULFONIC ACID	4450.	T
COCONUT/PALM KERNEL OIL	332355.	T
COOLING WATER	121570824.	M3
DOWTHERM	7200.	GJ
ELECTRICITY	398502720.	KWH
ETHYLENE	77564.	T
HYDROCHLORIC ACID	2666.	T
HYDROGEN (97 VOL %)	13911349.	M3
INERT GAS	13195137.	NM3
METHANE	3351543.	NM3
METHANOL	40957.	T
N-PARAFFINS C10-C13	81578.	T
NATURAL GAS	262467872.	T-CAL
NONENE (PROPYLENE TRIMER)	8055.	T
OXYGEN (MODERATE USAGE)	93214.	T
PALM OIL	494557.	T
PHOSPHORIC ACID (INDUSTRIAL GRADE)	51.	T
PROCESS WATER	16989060.	M3
SALT	80940.	T
SODIUM CHLORIDE	33280.	T
STEAM	2484293.	T
SULFUR	19878.	T
SULFUR TRIOXIDE	34622.	T

DOMESTIC S A L E

2-ETHYL HEXYL OLEATE	2000.	T
2-ETHYL HEXYL STEARATE	2000.	T
ALUMINIUM STEARATE	3000.	T
AMMONIUM LAURYL SULFATE SODIUM SALT	10000.	T
BARIUM STEARATE	4000.	T
BUTYL OLEATE	3000.	T
BUTYL STEARATE	6000.	T
CALCIUM STEARATE	6000.	T
CARBON DIOXIDE	51356.	T
CAUSTIC SODA	8741.	T
CNO/PKO FATTY ACIDS (TOPS/BOTOMS)	60639.	T
DI-GLYCEROL OLEATE	1000.	T
DI-GLYCEROL STEARATE	2000.	T
DIETHANOLAMINE	259.	T
FATTY AMINES ETHOXYLATE	4000.	T
FUEL GAS	10254473.	T-CAL
GLYCERIN	79041.	T
HYDROGEN AS FUEL	42833868.	T-CAL
LAURYL ALCOHOL ETHOXYLATE	75000.	T
LAURYL ALCOHOL ETHOXYSULFONATE Na	90000.	T
LAURYL ALCOHOL SULFONATE SODIUM SALT	70000.	T
LAURYL GLYCOL ETHER	2500.	T
MAGNESIUM STEARATE	1500.	T
METHYL ESTER FATTY ACIDS	40000.	T
MONOETHANOLAMINE	111.	T
NONYLPHENOL ETHOXYLATE	15000.	T
NONYLPHENOL ETHOXYSULFATE SODIUM SALT	30000.	T
OLEIC ACID	15000.	T
OLEIC ETHOXYLATE	5000.	T
PALM OIL FATTY ACIDS PRIMARY AMINES	4000.	T

POLYGLYCEROL OLEATE	1000.	T
POLYGLYCEROL STEARATE	2000.	T
POLYGLYCEROLS (MIXED)	665.	T
PRIMARY ALCOHOLS LINEAR, C12 & C14	20000.	T
SOAP	520000.	T
SODIUM ALKYLBENZYL SULFONATE	140000.	T
STEARIC ACID	25000.	T
STEARIC GLYCOL ESTER	2000.	T
SULFURIC ACID	1000.	T
SULFURIC ACID(IN 65%)	411.	T
TEA LAURYL ETHOXYSULFATE	5000.	T
TEA LAURYL SULFATE	5000.	T
ZINC STEARATE	4500.	T

P R O C E S S E S

2-ETHYLHEXYL OLEATE	2000.	T
2-ETHYLHEXYL STEARATE	2000.	T
ALLUMINIUM STEARATE	3000.	T
AMMONIUM LAURYL SULFATE	10000.	T
BARIUM STEARATE	4000.	T
BUTYL OLEATE	3000.	T
BUTYL STEARATE	6000.	T
CALCIUM STEARATE	6000.	T
CHLORINE (USING DIAPHRAGM CELLS)	47278.	T
DI-GLYCEROL OLEATE	1000.	T
DI-GLYCEROL STEARATE	2000.	T
EO BY ETHYLENE OXYGEN OXIDATION	92383.	T
ETHANOLAMINES FROM AMMONIA AND EO	3700.	T
FATTY ACIDS FROM PALM OIL (HYDROLYSIS)	154994.	T
FATTY AMINES ETHOXYLATE	4000.	T
FATTY AMINES FROM PALM OIL FATTY ACIDS	5292.	T
HYDRGENATION OF FATTY ACIDS	45507.	T
HYDROGENATION OF FATTY ACIDS	7961.	T
LAURYL GLYCOL ETHER	2500.	T
MAGNESIUM STEARATE	1500.	T
METHYL ESTERS FATTY ACIDS	40000.	T
MONOMETHYL ETHER	500.	T
NONYLPHENOL ETHOXYLATE NONIONIC SURFACT.	38100.	T
NONYLPHENOL ETHOXYSULFATE SODIUM SALT	30000.	T
OLEIC ACID (PO FATTY ACID DISTILLATION)	22745.	T
OLEIC/LINOLEIC ACID (PO FATTY ACID DIST)	45507.	T
OLEIN ETHOXYLATE	5000.	T
P-NONYLPHENOL (A BORON TRIFLUORIDE CAT.)	13762.	T
POLYGLYCEROL OLEATE	1000.	T
POLYGLYCEROL STEARATE	2000.	T
PRIMARY ALCOHOL ETHOXYLATE	147020.	T
PRIMARY ALCOHOL ETOXYSULFONATE	90000.	T
PRIMARY ALCOHOL SULFONATE	70000.	T
PRIMARY ALCOHOLS, LINEAR C12&C14	163888.	T
SOAP FROM PALM OIL (CLASSIC METHOD)	383496.	T
SOAP FROM PALMITIC ACID (CONT. METH.)	136503.	T
SOD. ALKYLBENZYL SULFONATE FROM N-PARAF.	140000.	T
STEARIC GLYCOL ESTER	2000.	T
SULFURIC ACID FROM SULFUR	6097.	T
TRIETANOLAMINE LAURYL ETHOXY SULFATE	5000.	T
TRIETANOLAMINE LAURYL SULFATE	5000.	T
ZINC STEARATE	4500.	T

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Experiment : INVMIN

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Problem title:    OLEOCHEMICALS and SURFACTANTS PDA

                   S i n g l e  Objective Optimization

Maximize:
         PDA Yearly Profit                                606.500 mil.$

Scenario:

      0. <   Investment                          <    1000. (100.0%) mil.$
 .00E+00 <   Yearly Import                       < 1.00E+14 (    .0%) mil.$
      0. < e 2-ETHYL HEXYL OLEATE                <    8000. (    .0%) T
      0. < e 2-ETHYL HEXYL STEARATE              <    8000. (    .0%) T
      0. < e ALUMINIUM STEARATE                  <   30000. (100.0%) T
      0. < e AMMONIUM LAURYL SULFATE SODIUM SALT <   20000. (    .0%) T
      0. < e BARIUM STEARATE                     <   40000. (100.0%) T
      0. < e BUTYL OLEATE                        <   20000. (    .0%) T
      0. < e BUTYL STEARATE                      <   20000. (    .0%) T
      0. < e CALCIUM STEARATE                    <   25000. (100.0%) T
      0. < e CNO/PKO FATTY ACIDS (TOPS/BOTOMS)   <  150000. (    .0%) T
      0. < e DI-GLYCEROL OLEATE                  <    3000. (100.0%) T
      0. < e DI-GLYCEROL STEARATE                <    6000. (100.0%) T
      0. < e FATTY AMINES ETHOXYLATE             <   15000. (100.0%) T
      0. < e LAURYL ALCOHOL ETHOXYLATE           <   80000. (    .0%) T
      0. < e LAURYL ALCOHOL ETHOXYSULFONATE Na   <   60000. (    .0%) T
      0. < e LAURYL ALCOHOL SULFONATE SODIUM SALT <  60000. (    .0%) T
      0. < e LAURYL GLYCOL ETHER                 <   10000. (    .0%) T
      0. < e MAGNESIUM STEARATE                  <   15000. (100.0%) T
      0. < e METHYL ESTER FATTY ACIDS            <   60000. (100.0%) T
      0. < e NONYLPHENOL ETHOXYSULFATE SODIUM SALT < 20000. (    .0%) T
      0. < e OLEIC ACID                          <  150000. (    .0%) T
      0. < e OLEIC ETHOXYLATE                    <   20000. (    .0%) T
      0. < e PALM OIL FATTY ACIDS PRIMARY AMINES <   15000. (100.0%) T
      0. < e POLYGLYCEROL OLEATE                 <    1000. (    .0%) T
      0. < e POLYGLYCEROL STEARATE               <    4000. (    .0%) T
      0. < e PRIMARY ALCOHOLS LINEAR, C12 & C14  <  160000. (    .0%) T
      0. < e SOAP                                <  500000. (    .0%) T
      0. < e SODIUM ALKYLBENZYL SULFONATE        <   90000. (    .0%) T
      0. < e STEARIC ACID                        <  150000. (    .0%) T
      0. < e STEARIC GLYCOL ESTER                <    4000. (    .0%) T
      0. < e TEA LAURYL ETHOXYSULFATE            <   20000. (    .0%) T
      0. < e TEA LAURYL SULFATE                  <   20000. (    .0%) T
      0. < e ZINC STEARATE                       <   45000. (100.0%) T
      0. < p COCONUT/PALM KERNEL OIL             <  960000. ( 13.4%) T
      0. < p PALM OIL                            < 2000000. ( 29.8%) T
      0. < s 2-ETHYL HEXYL OLEATE                <    2000. (100.0%) T
      0. < s 2-ETHYL HEXYL STEARATE              <    2000. (    .0%) T
      0. < s ALUMINIUM STEARATE                  <    3000. (100.0%) T
      0. < s AMMONIUM LAURYL SULFATE SODIUM SALT <   10000. (    .0%) T
      0. < s BARIUM STEARATE                     <    4000. (100.0%) T
      0. < s BUTYL OLEATE                        <    3000. ( 54.2%) T
      0. < s BUTYL STEARATE                      <    6000. (    .0%) T
      0. < s CALCIUM STEARATE                    <    6000. (100.0%) T
      0. < s CNO/PKO FATTY ACIDS (TOPS/BOTOMS)   <   30000. ( 58.7%) T
      0. < s DI-GLYCEROL OLEATE                  <    1000. (100.0%) T
      0. < s DI-GLYCEROL STEARATE                <    2000. (100.0%) T
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0.	< s	FATTY AMINES ETHOXYLATE	<	4000.	(100.0%)	T
0.	< s	GLYCERIN	<	30000.	(100.0%)	T
0.	< s	LAURYL ALCOHOL ETHOXYLATE	<	75000.	(100.0%)	T
0.	< s	LAURYL ALCOHOL ETHOXYSULFONATE Na	<	90000.	(.0%)	T
0.	< s	LAURYL ALCOHOL SULFONATE SODIUM SALT	<	70000.	(.0%)	T
0.	< s	LAURYL GLYCOL ETHER	<	2500.	(.0%)	T
0.	< s	MAGNESIUM STEARATE	<	1500.	(100.0%)	T
0.	< s	METHYL ESTER FATTY ACIDS	<	40000.	(100.0%)	T
0.	< s	NONYLPHENOL ETHOXYLATE	<	15000.	(100.0%)	T
0.	< s	NONYLPHENOL ETHOXYSULFATE SODIUM SALT	<	30000.	(100.0%)	T
0.	< s	OLEIC ACID	<	15000.	(100.0%)	T
0.	< s	OLEIC ETHOXYLATE	<	5000.	(100.0%)	T
0.	< s	PALM OIL FATTY ACIDS PRIMARY AMINES	<	4000.	(100.0%)	T
0.	< s	POLYGLYCEROL OLEATE	<	1000.	(100.0%)	T
0.	< s	POLYGLYCEROL STEARATE	<	2000.	(100.0%)	T
0.	< s	PRIMARY ALCOHOLS LINEAR, C12 & C14	<	20000.	(.0%)	T
0.	< s	SOAP	<	520000.	(70.2%)	T
0.	< s	SODIUM ALKYLBENZYL SULFONATE	<	140000.	(100.0%)	T
0.	< s	STEARIC ACID	<	25000.	(.0%)	T
0.	< s	STEARIC GLYCOL ESTER	<	2000.	(.0%)	T
0.	< s	SULFURIC ACID	<	1000.	(.0%)	T
0.	< s	TEA LAURYL ETHOXYSULFATE	<	5000.	(.0%)	T
0.	< s	TEA LAURYL SULFATE	<	5000.	(100.0%)	T
0.	< s	ZINC STEARATE	<	4500.	(100.0%)	T

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G L O B A L R E S U L T S

PDA Yearly Profit	607.	mil.$
PDA Value Added	906.	mil.$
Investment	1000.	mil.$
Yearly Import	83.	mil.$
Yearly Export	555	mil.$
Yearly Domestic Purchase	434.	mil.$
Yearly Domestic Sale	895.	mil.$

E X P O R T

ALUMINIUM STEARATE	30000.	T
BARIUM STEARATE	40000.	T
CALCIUM STEARATE	25000.	T
DI-GLYCEROL OLEATE	3000.	T
DI-GLYCEROL STEARATE	6000.	T
FATTY AMINES ETHOXYLATE	15000.	T
GLYCERIN	25627.	T
MAGNESIUM STEARATE	15000.	T
METHYL ESTER FATTY ACIDS	60000.	T
PALM OIL FATTY ACIDS PRIMARY AMINES	15000.	T
ZINC STEARATE	45000.	T

I M P O R T

2-ETHYLHEXANOL	680.	T
ACETIC ACID	75.	T
ALUMINA TRIHYDRATE	3300.	T

ALUMINUM PELLETS	406. T
BARIUM CARBONATE	13200. T
BORON TRIFLUORIDE	13. T
CALCIUM CARBONATE	5580. T
CATALYST AND CHEMICALS	5596598. USD
CHEMICALS	152856. USD
HEPTANE	11. T
MAGNESIUM OXIDE	1980. T
N-BUTANOL	398. T
PHENOL	5930. T
POTASSIUM CARBONATE	119. T
POTASSIUM HYDROXIDE	47532. T
SILICA GEL	182. T
TITANIUM DIOXIDE	730. T
ZINC (DUST)	5197. T

DOMESTIC P U R C H A S E

AMMONIA	3879. T
BENZENE	42952. T
CALCIUM CHLORIDE	610. T
CHLOROSULFONIC ACID	1190. T
COCONUT/PALM KERNEL OIL	128648. T
COOLING WATER	103327944. M3
DOWTHERM	18000. GJ
ELECTRICITY	459823744. KWH
ETHYLENE	56607. T
HYDROCHLORIC ACID	2666. T
HYDROGEN (97 VOL %)	44720416. M3
INERT GAS	29002648. NM3
METHANE	28602374. NM3
METHANOL	29526. T
N-PARAFFINS C10-C13	81578. T
NATURAL GAS	89092144. T-CAL
NONENE (PROPYLENE TRIMER)	8055. T
OXYGEN (MODERATE USAGE)	68028. T
PALM OIL	595739. T
PHOSPHORIC ACID (INDUSTRIAL GRADE)	51. T
PROCESS WATER	13257581. M3
SALT	80940. T
SODIUM CHLORIDE	1826. T
STEAM	22[illegible]1697. T
SULFUR	2700. T
SULFUR TRIOXIDE	34622. T
SULFURIC ACID	11343. T

DOMESTIC S A L E

2-ETHYL HEXYL OLEATE	2000. T
ALUMINIUM STEARATE	3000. T
BARIUM STEARATE	4000. T
BUTYL OLEATE	1625. T
CALCIUM STEARATE	6000. T
CARBON DIOXIDE	37479. T
CAUSTIC SODA	27948. T
CNO/PKO FATTY ACIDS (TOPS/BOTOMS)	17609. T
DI-GLYCEROL OLEATE	1000. T
DI-GLYCEROL STEARATE	2000. T

DIETHANOLAMINE	129.	T
FATTY AMINES ETHOXYLATE	4000.	T
FUEL GAS	7483727.	T-CAL
GLYCERIN	30000.	T
HYDROGEN AS FUEL	42833868.	T-CAL
LAURYL ALCOHOL ETHOXYLATE	75000.	T
MAGNESIUM STEARATE	1500.	T
METHYL ESTER FATTY ACIDS	40000.	T
MONOETHANOLAMINE	55.	T
NONYLPHENOL ETHOXYLATE	15000.	T
NONYLPHENOL ETHOXYSULFATE SODIUM SALT	30000.	T
OLEIC ACID	15000.	T
OLEIC ETHOXYLATE	5000.	T
PALM OIL FATTY ACIDS PRIMARY AMINES	1000.	T
POLYGLYCEROL OLEATE	1000.	T
POLYGLYCEROL STEARATE	2000.	T
POLYGLYCEROLS (MIXED)	2660.	T
SOAP	365228.	T
SODIUM ALKYLBENZYL SULFONATE	140000.	T
SULFURIC ACID(IN 65%)	411.	T
TEA LAURYL SULFATE	5000.	T
ZINC STEARATE	4500.	T

P R O C E S S E S

2-ETHYLHEXYL OLEATE	2000.	T
ALLUMINIUM STEARATE	33000.	T
BARIUM STEARATE	44000.	T
BUTYL OLEATE	1625.	T
CALCIUM STEARATE	31000.	T
CHLORINE (USING DIAPHRAGM CELLS)	47278.	T
DI-GLYCEROL OLEATE	4000.	T
DI-GLYCEROL STEARATE	8000.	T
EO BY ETHYLENE OXYGEN OXIDATION	67421.	T
ETHANOLAMINES FROM AMMONIA AND EO	1850.	T
FATTY ACIDS FROM PALM OIL (HYDROLYSIS)	413125.	T
FATTY AMINES ETHOXYLATE	15000.	T
FATTY AMINES FROM PALM OIL FATTY ACIDS	25137.	T
HYDRGENATION OF FATTY ACIDS	153819.	T
HYDROGENATION OF FATTY ACIDS	8328.	T
MAGNESIUM STEARATE	16500.	T
METHYL ESTERS FATTY ACIDS	100000.	T
NONYLPHENOL ETHOXYLATE NONIONIC SURFACT.	38100.	T
NONYLPHENOL ETHOXYSULFATE SODIUM SALT	30000.	T
OLEIC ACID (PO FATTY ACID DISTILLATION)	23795.	T
OLEIC/LINOLEIC ACID (PO FATTY ACID DIST)	158819.	T
OLEIN ETHOXYLATE	5000.	T
P-NONYLPHENOL (A BORON TRIFLUORIDE CAT.)	13762.	T
POLYGLYCEROL OLEATE	1000.	T
POLYGLYCEROL STEARATE	2000.	T
PRIMARY ALCOHOL ETHOXYLATE	75000.	T
PRIMARY ALCOHOLS, LINEAR C12&C14	47592.	T
SOAP FROM PALMITIC ACID (CONT. METH.)	365228.	T
SOD. ALKYLBENZYL SULFONATE FROM N-PARAF.	140000.	T
TRIETANOLAMINE LAURYL SULFATE	5000.	T
ZINC STEARATE	49500.	T

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Experiment : RATIO

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Problem title:    OLEOCHEMICALS and SURFACTANTS PDA

                  F r a c t i o n a l  Optimization

Maximize:
         PDA Yearly Profit                                      mil.$
         -------------------------------------- =        .527 --------
         Investment                                             mil.$

Scenario:

1.60E+03 <   Investment                         <      none (   .0%) mil.$
 .00E+00 <   Yearly Import                      < 1.00E+14 (   .0%) mil.$
      0. < e 2-ETHYL HEXYL OLEATE               <     8000. (   .0%) T
      0. < e 2-ETHYL HEXYL STEARATE             <     8000. (   .0%) T
      0. < e ALUMINIUM STEARATE                 <    30000. (100.0%) T
      0. < e AMMONIUM LAURYL SULFATE SODIUM SALT <   20000. (   .0%) T
      0. < e BARIUM STEARATE                    <    40000. (100.0%) T
      0. < e BUTYL OLEATE                       <    20000. (   .0%) T
      0. < e BUTYL STEARATE                     <    20000. (   .0%) T
      0. < e CALCIUM STEARATE                   <    25000. (100.0%) T
      0. < e CNO/PKO FATTY ACIDS (TOPS/BOTOMS)  <   150000. ( 10.8%) T
      0. < e DI-GLYCEROL OLEATE                 <     3000. (100.0%) T
      0. < e DI-GLYCEROL STEARATE               <     6000. (100.0%) T
      0. < e FATTY AMINES ETHOXYLATE            <    15000. (100.0%) T
      0. < e LAURYL ALCOHOL ETHOXYLATE          <    80000. ( 23.3%) T
      0. < e LAURYL ALCOHOL ETHOXYSULFONATE Na  <    60000. (   .0%) T
      0. < e LAURYL ALCOHOL SULFONATE SODIUM SALT <  60000. (   .0%) T
      0. < e LAURYL GLYCOL ETHER                <    10000. (   .0%) T
      0. < e MAGNESIUM STEARATE                 <    15000. (100.0%) T
      0. < e METHYL ESTER FATTY ACIDS           <    60000. (100.0%) T
      0. < e NONYLPHENOL ETHOXYSULFATE SODIUM SALT < 20000. (100.0%) T
      0. < e OLEIC ACID                         <   150000. ( 69.1%) T
      0. < e OLEIC ETHOXYLATE                   <    20000. (100.0%) T
      0. < e PALM OIL FATTY ACIDS PRIMARY AMINES <   15000. (100.0%) T
      0. < e POLYGLYCEROL OLEATE                <     1000. (100.0%) T
      0. < e POLYGLYCEROL STEARATE              <     4000. (100.0%) T
      0. < e PRIMARY ALCOHOLS LINEAR, C12 & C14 <   160000. (   .0%) T
      0. < e SOAP                               <   500000. (   .0%) T
      0. < e SODIUM ALKYLBENZYL SULFONATE       <    90000. (100.0%) T
      0. < e STEARIC ACID                       <   150000. (   .0%) T
      0. < e STEARIC GLYCOL ESTER               <     4000. (   .0%) T
      0. < e TEA LAURYL ETHOXYSULFATE           <    20000. (   .0%) T
      0. < e TEA LAURYL SULFATE                 <    20000. (   .0%) T
      0. < e ZINC STEARATE                      <    45000. (100.0%) T
      0. < p COCONUT/PALM KERNEL OIL            <   960000. ( 28.3%) T
      0. < p PALM OIL                           <  2000000. ( 41.6%) T
      0. < s 2-ETHYL HEXYL OLEATE               <     2000. (100.0%) T
      0. < s 2-ETHYL HEXYL STEARATE             <     2000. (   .0%) T
      0. < s ALUMINIUM STEARATE                 <     3000. (100.0%) T
      0. < s AMMONIUM LAURYL SULFATE SODIUM SALT <   10000. (   .0%) T
      0. < s BARIUM STEARATE                    <     4000. (100.0%) T
      0. < s BUTYL OLEATE                       <     3000. (100.0%) T
      0. < s BUTYL STEARATE                     <     6000. (   .0%) T
      0. < s CALCIUM STEARATE                   <     6000. (100.0%) T
      0. < s CNO/PKO FATTY ACIDS (TOPS/BOTOMS)  <    30000. (100.0%) T
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0.	<	s	DI-GLYCEROL OLEATE	<	1000.	(100.0%)	T
0.	<	s	DI-GLYCEROL STEARATE	<	2000.	(100.0%)	T
0.	<	s	FATTY AMINES ETHOXYLATE	<	4000.	(100.0%)	T
0.	<	s	GLYCERIN	<	30000.	(100.0%)	T
0.	<	s	LAURYL ALCOHOL ETHOXYLATE	<	75000.	(100.0%)	T
0.	<	s	LAURYL ALCOHOL ETHOXYSULFONATE Na	<	90000.	(100.0%)	T
0.	<	s	LAURYL ALCOHOL SULFONATE SODIUM SALT	<	70000.	(.0%)	T
0.	<	s	LAURYL GLYCOL ETHER	<	2500.	(100.0%)	T
0.	<	s	MAGNESIUM STEARATE	<	1500.	(100.0%)	T
0.	<	s	METHYL ESTER FATTY ACIDS	<	40000.	(100.0%)	T
0.	<	s	NONYLPHENOL ETHOXYLATE	<	15000.	(100.0%)	T
0.	<	s	NONYLPHENOL ETHOXYSULFATE SODIUM SALT	<	30000.	(100.0%)	T
0.	<	s	OLEIC ACID	<	15000.	(100.0%)	T
0.	<	s	OLEIC ETHOXYLATE	<	5000.	(100.0%)	T
0.	<	s	PALM OIL FATTY ACIDS PRIMARY AMINES	<	4000.	(100.0%)	T
0.	<	s	POLYGLYCEROL OLEATE	<	1000.	(100.0%)	T
0.	<	s	POLYGLYCEROL STEARATE	<	2000.	(100.0%)	T
0.	<	s	PRIMARY ALCOHOLS LINEAR, C12 & C14	<	20000.	(100.0%)	T
0.	<	s	SOAP	<	520000.	(100.0%)	T
0.	<	s	SODIUM ALKYLBENZYL SULFONATE	<	140000.	(100.0%)	T
0.	<	s	STEARIC ACID	<	25000.	(.0%)	T
0.	<	s	STEARIC GLYCOL ESTER	<	2000.	(.0%)	T
0.	<	s	SULFURIC ACID	<	1000.	(.0%)	T
0.	<	s	TEA LAURYL ETHOXYSULFATE	<	5000.	(100.0%)	T
0.	<	s	TEA LAURYL SULFATE	<	5000.	(100.0%)	T
0.	<	s	ZINC STEARATE	<	4500.	(100.0%)	T

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G L O B A L R E S U L T S

PDA Yearly Profit	844.	mil.$
PDA Value Added	1305.	mil.$
Investment	1600.	mil.$
Yearly Import	114.	mil.$
Yearly Export	914.	mil.$
Yearly Domestic Purchase	692.	mil.$
Yearly Domestic Sale	1238.	mil.$

E X P O R T

ALUMINIUM STEARATE	30000.	T
BARIUM STEARATE	40000.	T
CALCIUM STEARATE	25000.	T
CNO/PKO FATTY ACIDS (TOPS/BOTOMS)	16149.	T
DI-GLYCEROL OLEATE	3000.	T
DI-GLYCEROL STEARATE	6000.	T
FATTY AMINES ETHOXYLATE	15000.	T
GLYCERIN	58541.	T
LAURYL ALCOHOL ETHOXYLATE	18636.	T
MAGNESIUM STEARATE	15000.	T
METHYL ESTER FATTY ACIDS	60000.	T
NONYLPHENOL ETHOXYSULFATE SODIUM SALT	20000.	T
OLEIC ACID	103695.	T
OLEIC ETHOXYLATE	20000.	T
PALM OIL FATTY ACIDS PRIMARY AMINES	15000.	T
POLYGLYCEROL OLEATE	1000.	T

POLYGLYCEROL STEARATE	4000.	T
SODIUM ALKYLBENZYL SULFONATE	90000.	T
ZINC STEARATE	45000.	T

I M P O R T

2-ETHYLHEXANOL	680.	T
ACETIC ACID	166.	T
ALUMINA TRIHYDRATE	3300.	T
ALUMINUM PELLETS	667.	T
BARIUM CARBONATE	13200.	T
BORON TRIFLUORIDE	18.	T
CALCIUM CARBONATE	5580.	T
CATALYST AND CHEMICALS	12242859.	USD
CHEMICALS	228156.	USD
HEPTANE	15.	T
MAGNESIUM OXIDE	1980.	T
N-BUTANOL	735.	T
PHENOL	8327.	T
POTASSIUM CARBONATE	223.	T
POTASSIUM HYDROXIDE	67737.	T
SILICA GEL	299.	T
TITANIUM DIOXIDE	1040.	T
ZINC (DUST)	5197.	T

DOMESTIC P U R C H A S E

AMMONIA	4113.	T
BENZENE	70564.	T
CALCIUM CHLORIDE	1002.	T
CHLOROSULFONIC ACID	2380.	T
COCONUT/PALM KERNEL OIL	271576.	T
COOLING WATER	176756448.	M3
DOWTHERM	24000.	GJ
ELECTRICITY	720463104.	KWH
ETHYLENE	106299.	T
HYDROCHLORIC ACID	4381.	T
HYDROGEN (97 VOL %)	45360016.	M3
INERT GAS	42416124.	NM3
METHANE	28628114.	NM3
METHANOL	44964.	T
N-PARAFFINS C10-C13	134021.	T
NATURAL GAS	211310592.	T-CAL
NONENE (PROPYLENE TRIMER)	11310.	T
OXYGEN (MODERATE USAGE)	127746.	T
PALM OIL	832236.	T
PHOSPHORIC ACID (INDUSTRIAL GRADE)	72.	T
PROCESS WATER	18016044.	M3
SALT	132973.	T
SODIUM CHLORIDE	2600.	T
STEAM	3755226.	T
SULFUR	17339.	T
SULFUR TRIOXIDE	56879.	T

DOMESTIC S A L E

2-ETHYL HEXYL OLEATE	2000.	T

ALUMINIUM STEARATE	3000.	T
BARIUM STEARATE	4000.	T
BUTYL OLEATE	3000.	T
CALCIUM STEARATE	6000.	T
CARBON DIOXIDE	70381.	T
CAUSTIC SODA	36821.	T
CNO/PKO FATTY ACIDS (TOPS/BOTOMS)	30000.	-
DI-GLYCEROL OLEATE	1000.	T
DI-GLYCEROL STEARATE	2000.	T
DIETHANOLAMINE	259.	T
FATTY AMINES ETHOXYLATE	4000.	T
FUEL GAS	14053344.	T-CAL
GLYCERIN	30000.	T
HYDROGEN AS FUEL	70369928.	T-CAL
LAURYL ALCOHOL ETHOXYLATE	75000.	T
LAURYL ALCOHOL ETHOXYSULFONATE Na	90000.	T
LAURYL GLYCOL ETHER	2500.	T
MAGNESIUM STEARATE	1500.	T
METHYL ESTER FATTY ACIDS	40000.	T
MONOETHANOLAMINE	111.	T
NONYLPHENOL ETHOXYLATE	15000.	T
NONYLPHENOL ETHOXYSULFATE SODIUM SALT	30000.	T
OLEIC ACID	15000.	T
OLEIC ETHOXYLATE	5000.	T
PALM OIL FATTY ACIDS PRIMARY AMINES	4000.	T
POLYGLYCEROL OLEATE	1000.	T
POLYGLYCEROL STEARATE	2000.	T
POLYGLYCEROLS (MIXED)	2660.	T
PRIMARY ALCOHOLS LINEAR, C12 & C14	20000.	T
SOAP	520000.	T
SODIUM ALKYLBENZYL SULFONATE	140000.	T
SULFURIC ACID(IN 65%)	675.	T
TEA LAURYL ETHOXYSULFATE	5000.	T
TEA LAURYL SULFATE	5000.	T
ZINC STEARATE	4500.	T

P R O C E S S E S

2-ETHYLHEXYL OLEATE	2000.	T
ALLUMINIUM STEARATE	33000.	T
BARIUM STEARATE	44000.	T
BUTYL OLEATE	3000.	T
CALCIUM STEARATE	31000.	T
CHLORINE (USING DIAPHRAGM CELLS)	77671.	T
DI-GLYCEROL OLEATE	4000.	T
DI-GLYCEROL STEARATE	8000.	T
EO BY ETHYLENE OXYGEN OXIDATION	126607.	T
ETHANOLAMINES FROM AMMONIA AND EO	3700.	T
FATTY ACIDS FROM PALM OIL (HYDROLYSIS)	616637.	T
FATTY AMINES ETHOXYLATE	19000.	T
FATTY AMINES FROM PALM OIL FATTY ACIDS	25137.	T
HYDRGENATION OF FATTY ACIDS	121150.	T
HYDROGENATION OF FATTY ACIDS	48598.	T
LAURYL GLYCOL ETHER	2500.	T
MAGNESIUM STEARATE	16500.	T
METHYL ESTERS FATTY ACIDS	100000.	T
NONYLPHENOL ETHOXYLATE NONIONIC SURFACT.	53500.	T
NONYLPHENOL ETHOXYSULFATE SODIUM SALT	50000.	T
OLEIC ACID (PO FATTY ACID DISTILLATION)	138850.	T

OLEIC/LINOLEIC ACID (PO FATTY ACID DIST)	121150. T
OLEIN ETHOXYLATE	25000. T
P-NONYLPHENOL (A BORON TRIFLUORIDE CAT.)	19324. T
POLYGLYCEROL OLEATE	2000. T
POLYGLYCEROL STEARATE	6000. T
PRIMARY ALCOHOL ETHOXYLATE	165656. T
PRIMARY ALCOHOL ETOXYSULFONATE	90000. T
PRIMARY ALCOHOLS, LINEAR C12&C14	124727. T
SOAP FROM PALMITIC ACID (CONT. METH.)	520000. T
SOD. ALKYLBENZYL SULFONATE FROM N-PARAF.	230000. T
SULFURIC ACID FROM SULFUR	17207. T
TRIETANOLAMINE LAURYL ETHOXY SULFATE	5000. T
TRIETANOLAMINE LAURYL SULFATE	5000. T
ZINC STEARATE	49500. T

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Experiments : RATIO, DEBT and RISC – differences

		ratio	debt	risk
Simple Rate of Return		0.527	0.457	0.344
GLOBAL RESULTS				
PDA Yearly Profit	mil.$	844	732	550
PDA Value Added	mil.$	1305	1305	984
Yearly Import	mil.$	114	114	114
Yearly Export	mil.$	914	914	758
Yearly Domestic Purchase	mil.$	692	692	658
Yearly Domestic Sale	mil.$	1238	1238	1039
EXPORT				
CNO/PKO FATTY ACIDS (TOPS/BOT)	T	16149	16149	17895
GLYCERIN	T	58541	58541	59552
LAURYL ALCOHOL ETHOXYLATE	T	18636	18636	32462
SODIUM ALKYLBENZYL SULFONATE	T	90000	90000	0
TEA LAURYL ETHOXYSULFATE	T	0	0	20000
TEA LAURYL SULFATE	T	0	0	20000
IMPORT				
ACETIC ACID	T	166	166	187
ALUMINUM PELLETS	T	667	667	406
CATALYST AND CHEMICALS	USD	12242859	12242859	12679409
POTASSIUM CARBONATE	T	223	223	262
POTASSIUM HYDROXIDE	T	67737	67737	67742
SILICA GEL	T	299	299	182
DOMESTIC PURCHASE				
AMMONIA	T	4113	4113	7645
BENZENE	T	70564	70564	42952
CALCIUM CHLORIDE	T	1002	1002	610
CHLOROSULFONIC ACID	T	2380	2380	13970
COCONUT/PALM KERNEL OIL	T	271576	271576	278899
COOLING WATER	M3	176756448	176756448	178261296
ELECTRICITY	KWH	720463104	720463104	624051136
ETHYLENE	T	106299	106299	125090
HYDROCHLORIC ACID	T	4381	4381	2666
INERT GAS	NM3	42416124	42416124	42482180
METHANE	NM3	28628114	28628114	28628488
METHANOL	T	44964	44964	45908
N-PARAFFINS C10-C13	T	134021	134021	81578
NATURAL GAS	T-CAL	211310592	211310592	218652288
OXYGEN (MODERATE USAGE)	T	127746	127746	150329
PROCESS WATER	M3	18016044	18016044	18457342
SALT	T	132973	132973	80940
STEAM	T	3755226	3755226	3646996
SULFUR	T	17339	17339	17258
SULFUR TRIOXIDE	T	56879	56879	34622
DOMESTIC SALE				
AMMONIUM LAURYL SULFATE	T	0	0	10000
CARBON DIOXIDE	T	70381	70381	82822

CAUSTIC SODA	T	36821	36821	16610
DIETHANOLAMINE	T	259	259	1295
FUEL GAS	T-CAL	14053344	14053344	16537638
HYDROGEN AS FUEL	T-CAL	70369928	70369928	42833868
MONOETHANOLAMINE	T	111	111	555
PRIMARY ALCOHOLS LINEAR,C12-14	T	20000	20000	0
SULFURIC ACID(IN 65%)	T	675	675	411

P R O C E S S E S

AMMONIUM LAURYL SULFATE	T	0	0	10000
AUX FOR LINEAR ALCOHOLS	T	104727	104727	129445
CHLORINE (USING DIAPHRAGM CELL	T	77671	77671	47278
EO BY ETHYLENE OXYGEN OXIDAT.	T	126607	126607	148988
ETHANOLAMINES FROM AMMONIA &EO	T	3700	3700	18500
PRIMARY ALCOHOL ETHOXYLATE	T	165656	165656	187482
PRIMARY ALCOHOLS,LINEAR C12&C14	T	124727	124727	129445
SOD. ALKYLBENZYL SULFONATE	T	230000	230000	140000
TEA LAURYL ETHOXY SULFATE	T	5000	5000	25000
TRIETANOLAMINE LAURYL SULFATE	T	5000	5000	25000